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TECHNOLOGICAL PROBLEMS IN THE USE OF ALTERNATE FUELS IN THE GLASS INDUSTRY

By ROY S. ARRANDALE

Thatcher Glass Manufacturing Co., Elmira, N. Y.

PART I

It goes without saying that there is a general shortage of one kind of fuel or another at any particular time or place, even though the overall energy requirement is still being met. However, it is hard at times to decide which is the alternate fuel, since in the same company that which is standby in one plant is regular fuel in another, and vice versa.

The subject of alternate fuels therefore involves all fuels. However, natural gas being what it is, viz., the most convenient and simple of all fuels to use and apply, the big problem for most of us involves a substitution for natural gas. As to what has happened to natural gas, the plain and simple answer is that it has gone off in search of higher income brackets—generally speaking, it has become too valuable a material to be junked in the form of industrial heat. Some day it will no doubt prove too valuable to be junked in the form of domestic heat also.

It is the misfortune of the glass industry not to have any by-product wastes which will burn, although one batch mixer has said that we put sawdust in the glass so the housewife can use a milk bottle to start a fire in the cook stove. Also, since a method has not been worked out as yet for applying solid fuels directly to modern glass factory equipment (boilers excepted), we are limited to liquid and gaseous substitutions either directly or indirectly.

The greatest urgency at the moment in the application of alternate fuels lies in the substitution for clean and dry natural gas in operations which require very accurate control, wherein the combustion space is necessarily limited, and where the main fuel stream must be manifolded or broken up into many small streams, each of relatively small volume. For the same results as before, a dilute source of heat is preferred—viz., a gas as opposed to a liquid, wherein the fluid stream and the fire stay within limits of easy control. Even though the following is written with particular reference to the manufacture of glass containers, the problem is much the same in other branches of the industry. In other words, what is needed right now is a reliable source of clean gas.

At the present time there are only three substitutes in clean gaseous form for ready-made application to equipment (in particular forehearths and lehrs) which are designed for natural gas and normally fired with natural gas.

1. Oil-vapor gas
2. Propane
3. Anthracite gas

Coke oven gas, of course, is not ordinarily considered as a substitute fuel. It is an excellent fuel and can be applied to forehearths and lehrs with results equivalent to that of natural gas. Also, with suitable modification it is equally applicable to the melting operation itself, as has been performed this year, in fact, at Neville Island Glass Company, Pittsburgh.

Oil-Vapor-Gas

The device shown in Figures 1 and 2 is a comparatively simple, small oil-vapor generator manufactured by the Vapofier Corporation of Chicago, which serves the primary purpose of supplying a continuous premixed air-gas stream ready for complete combustion. Inspirating air is supplied by a blower to the venturi mixer shown at the top of the pot. This serves to put the pot itself under suction and also provides the necessary air for combustion. The pilot flame which is directed down against the orifice in the top of the pot is sucked into the alloy combustion tube which is itself immersed at the lower end about 5/8" into the oil pool lying in the bottom of the pot. The oil level is maintained constant by means of a float valve operating on the gravity feed line. The hot

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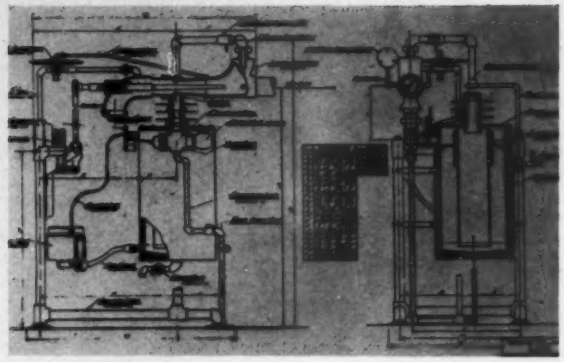


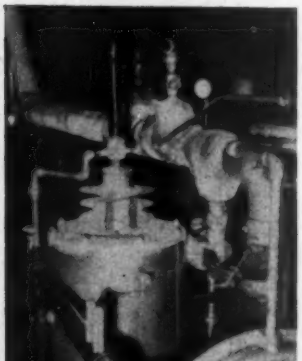
Courtesy, Vapofier Corp., Chicago, Ill.

Fig. 1. "Vapofier" oil vapor generator unit.

oil vapors pulled from the pool then pass up through a small annular superheater and through the side outlet connected to the air inspirator.

The downstream pressure on the system is automatically controlled by the pilot and power diaphragm assembly which moves the center rod of the inspirator in and out. The proportion of oil and air is controlled by the movement of the slide valve in the discharge connection from the pot. In operation on No. 1 fuel oil with an end point of around 600° F., the Vapofier will vaporize continuously without interruption other than that occasioned by the insertion of a clean, vapor slide valve which has to be done regularly at a minimum of once a day, and preferably once each shift. A certain amount of residue also collects in the inspirator itself and requires dismantling for cleaning about once each week.

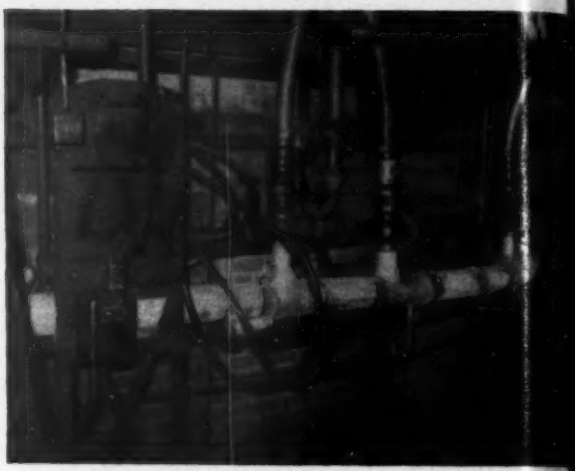
As can readily be seen, it is best to provide a spare unit piped in parallel arrangement, when 24 hour operation is required. The unit is started on natural gas fed to the pilot, and from the cold requires about 5 minutes time, at which time the unit is self sufficient on oil. Regulation of the air-vapor mixture is by visual observation of the pilot flame, which seems rather crude but actually works out pretty well. The normal flame is a bright blue with a purplish cast in the interior. For convenience in starting up it is best to provide a vent to the open air from some point in the header, such that the unit can be heated up without interruption of the flame at the point of consumption. Otherwise the burner tips of the forehearth in particular get chilled to the point where the gas fails to ignite even at forehearth temperature. Natural gas can also be connected to the unit to provide a blend of gas and oil vapor if desired.



Courtesy, Thatcher Glass Mfg. Co., Olean, New York.

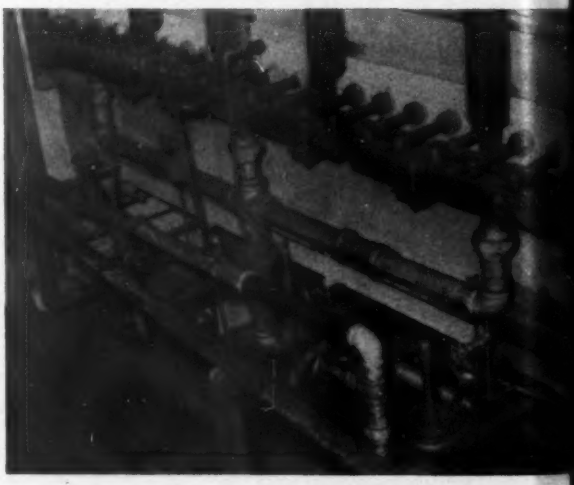
Fig. 2. "Vapofier" unit in operation supplying oil-vapor fuel to forehearths.

The gas produced is not a stable gas but really in effect a fog, the cold air producing a mixture which is below the dew point. Consequently condensation on the walls of the piping is important, not especially from the standpoint of vaporizing capacity, but mainly from the standpoint of backfire, the ideal conditions for which are set up by condensate in the burner manifold. The distance over which the gas can be distributed is therefore limited to about 50 ft. in accordance with the manufacturer's recommendations but actually has been run up to about 100 ft. or more with favorable results. As applied in substitution for natural gas it is considered best to block out the normal natural gas inspirators, automatic control equipment, etc., in the form of a by-pass and to control the oil-vapor gas distribution by means of manual adjustment of graduated butterfly valves. The same burner system is employed if the natural gas system is of the premix type. In a few cases it is necessary to use larger burner tips. Overall, 1-gallon of No. 1 oil displaces about 110 C. F. of natural gas.



Courtesy, Thatcher Glass Mfg. Co., Olean, New York.

Fig. 3. Oil vapor manifold supplying forehearths.



Courtesy, Thatcher Glass Mfg. Co., Olean, New York.

Fig. 4. Hartford-Empire "KW" forehearth burner manifold.

It is desirable to run condensate taps from all sections of the header, right up to and including the burner manifold itself (see Figures 3 and 4). The amount of liquid collected is very small but is important nevertheless. If

the Vapofier generator is lower than the manifold, as is best, the condensate drains directly back to the pot; otherwise a condensate sump and pump is provided.

Usually, space is critical around the working end of a container furnace and it is sometimes a problem to locate a generator unit within a suitable distance. A convenient solution is to mount the unit on top of one of the lehrs as shown in Figure 5, either to supply the lehrs themselves or the forehearths. One Vapofier of the largest size (No. 10) will handle two forehearths satisfactorily or seven annealing lehrs. It has also been found feasible to feed gas into more than one point in a common header

Courtesy, Thatcher Glass Mfg. Co., Olean, New York.

Fig. 5. Vapofier installation on top of annealing lehr.

Courtesy, Thatcher Glass Mfg. Co., Elmira, New York.

Fig. 6. Vapofier installation on top of pyroglaze lehr.

system even though the manufacturer's recommendation is that they be completely divorced one from the other, and that the piping be as simple and streamlined as possible—which, for example, is probably at its ideal in the case of Figure 6.

The Vapofier generator will also operate on No. 2 oil but on account of the higher per cent carbon residue and the lower volatility the operation is not as satisfactory. The principal result is an accumulation of coke in the bottom of the pot in from 3 to 5 days time which puts the unit down for cleaning.

There is another unit of more recent origin, called the "Pter-O-Fire" unit on the Pacific Coast and the "ALGAS" (American Liquid Gas Corporation of Los Angeles) elsewhere, which is made in much larger sizes, as high as 25 MM BTU/Hr. It is claimed with reasonable basis that a heavier oil can be handled with less carbon formation. In a recent communication a test run is described wherein the oil used was halfway between a No. 2 and a No. 3. A unit of this type is shown in Figures 7 and 8 as installed on a large enamelling oven. The principle involved here is that of injecting liquid hydrocarbon into a stream of pre-heated air (around 600° F.) at a point near the burners: The flashed oil vapor and air premix then flows through the burner.

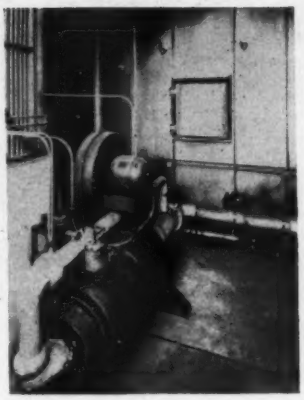


Fig. 7

The system is dual; that is, fires natural gas or oil-vapor alternately. Change-over to oil simply requires the lighting of a gas burner in the air pre-heater (Figure 7) and manual adjustment of the oil feed. Gas is bled in until air temperature is high enough to automatically cut in the oil carburetor on the pre-heater proper. The products of combustion go directly into the air stream. In a carburetor (Venturi mixer) on the burner manifold of Figure 8 the liquid oil is vaporized and after the stream temperature reaches 600° F., or its pre-determined setting, natural gas automatically cuts out of the system. Gas is normally admitted at the same Venturi—but the air stream in that case is not pre-heated.

Propane

Liquefied petroleum gases, butane and propane, are obtained commercially from two principal sources, 1) from natural gas in the large scale scrubbing operations which reclaim a natural gasoline, and 2) off-gases produced in the refining of petroleum. At one time butane was preferable in view of its lower storage pressure as compared with propane. Later so many valuable uses arose for the C_4, or butane cut, that it virtually disappeared from usage as an industrial fuel. Whether the same will happen to industrial propane is a moot question.

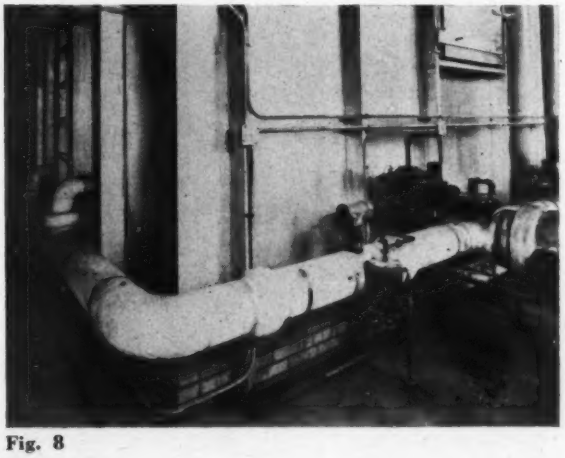
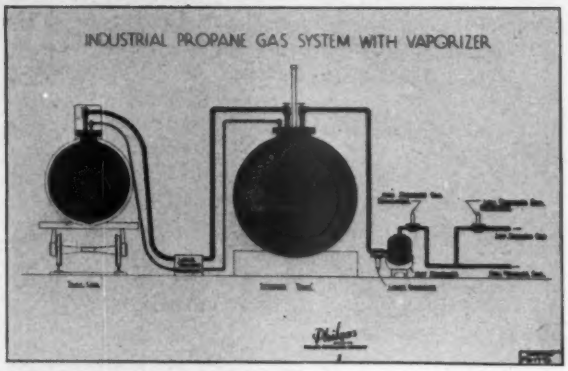


Fig. 8

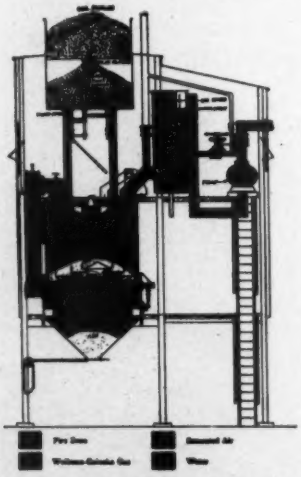


Courtesy, Phillips Petroleum Co., New York, N. Y.

Fig. 9.

Some completely integrated refineries had no propane for external sale as far back as 1937 or 1938. While C_3 does not match synthetic attractiveness of C_4 in that it can have no isomer like isobutane, its use as a chemical raw material has increased by leaps and bounds. Now on a new phase, the steam cracking of propane (and also methane) provides the petroleum industry with the potential hydrogen source that it will eventually want. One plant in operation since 1931 has produced up to 19 MM C.F.D. of hydrogen (10% of total U.S. production) by the light hydrocarbon-steam reaction. Regardless of all this, however, propane in the future will probably always be available at least in some degree as a liquid-gas fuel inasmuch as the uses to which it is put is a question overall of dollars and cents to the producer. If it would bring as much back to the overall, operation without further processing, there would hardly be any point in putting it anywhere else but directly into fuel. Likewise the scale of operation at many points of production, both in natural gas scrubbing and in refining, is not large enough to justify the tremendous investment outlay involved in further utilization of propane and other "light ends" at the source, any more than methane or natural gas could be so utilized.

Industrial propane in liquid form has a vapor pressure of 122 p.s.i.g. at 70° F. (282 p.s.i.g. at 130° F.)[13]; weight per gallon at 60° F. is 4.26 lbs.; and gross heat of combustion 91,800 BTU/Gal. — 2537 B.T.U./Cu. Ft. of gas after vaporization. It is generally shipped in special tank cars of about 9,600 gallons. Storage tanks generally run from 12,000-30,000 gal. capacity. A 30,000 gallon tank therefore has a potential gas capacity of 1,085,400 cu. ft. (60° F.; 1 Atm) or 2750 MM BTU.



Courtesy, The Wellman Engineering Co., New York, N. Y.

Fig. 10. Wellman-Galusha anthracite gas producer.

For some installations and in warm weather propane will vaporize at a fast enough rate from the storage tank proper to supply its system, but generally an auxiliary steam-heated vaporizer is used (Figure 9.) Gas can either be supplied pure at low or high pressures but more commonly it is diluted with air to give a gas of the same inspirating characteristics as natural gas which is then put through the natural gas system.

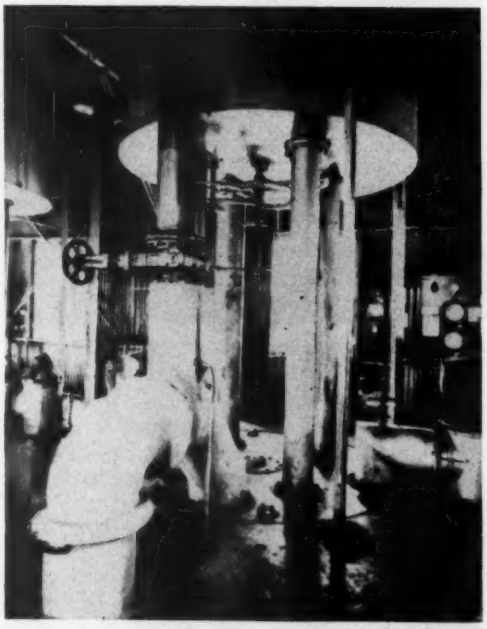
Without question propane is the best possible substitute for natural gas. The installation is fairly simple, the change-over from one to the other is easy and quick, and its burning qualities are every bit the equal of natural gas. By the same token, however, it has the same weaknesses of natural gas—viz., the physical impossibility of storing it up as one would a coal pile; plus a long supply in summer and a short supply in winter.

Anthracite Gas

Clean gas generated from anthracite fines has not had the attention it deserves insofar as the glass industry is concerned. To date, with one single exception, no application has been made in the glass industry. One plant is now using it on a moderate scale to fire forehearths. In the metallurgical and pottery fields it has been used extensively for a number of years.

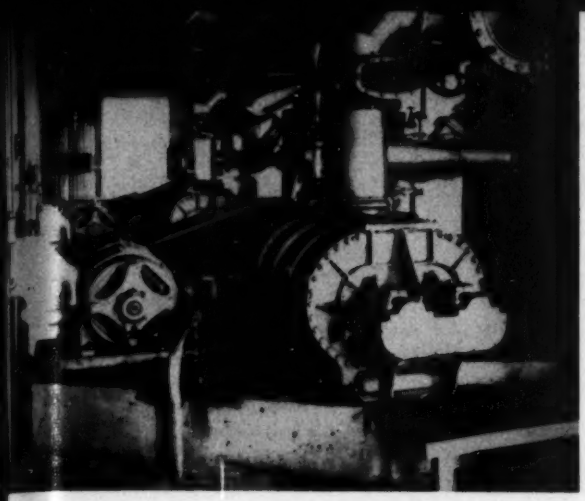
Coke breeze can also be employed but more generally it is the fine grades of anthracite; "Rice" (5/16"-3/16") in particular and "Barley" (3/16"-3/32") sometimes.

The Galusha producer (now the Wellman-Galusha) of Figure 10 is a smoothly operating unit made in sizes up to 10 ft. diameter, which will handle nicely 2000 lbs./hour of "rice" or 1600 lbs./hr. of "Barley". In operation, coal feeds by gravity through a valve sealing arrangement indicated in the feed hopper. Blast air from the fan passes over the water in the water jacket and picks up enough water vapor en route to supply the water gas reaction. In other words, the unit is self-sufficient in steam. The blast air then passes up through the revolving grate at the bottom. Ash drops through into the



Courtesy, The Wellman Engineering Co., New York, N. Y.

Fig. 11. Operating floor Wellman-Galusha anthracite gas producer.

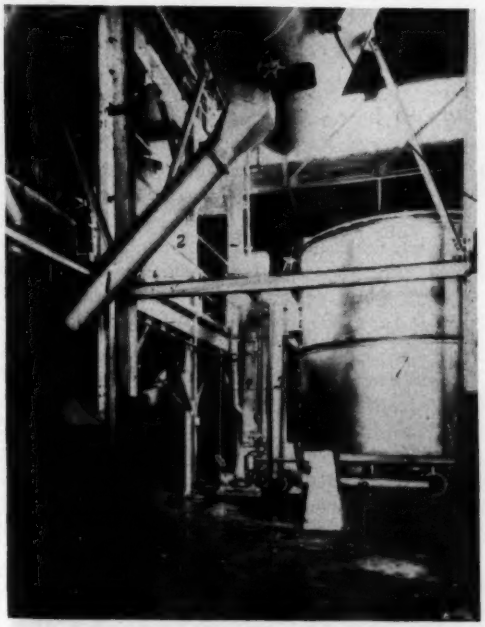


Courtesy, The Wellman Engineering Co., New York, N. Y.

Fig. 12. Anthracite gas compressors.

hopper at the bottom for easy removal. The hot gas off the top can either be used to supply a reasonably clean, hot gas (about 500° F.) for fuel or more generally is passed through a water scrubber filled with coke which removes principally fine dust and most of the H_2S. Cool gas is compressed to 2-3 psig for distribution through the fuel system, composed of light gage spiral piping.

The operating floor of one of a battery of 3-10 ft. units is depicted in Figure 11; the type of compressor used in Figure 12. If the hydrogen sulfide content needs to be reduced still further, the compressed gas is passed through an iron-oxide "box" for further clean-up. In Figure 13 is shown the iron oxide tank of an installation in a large pottery wherein the gas is used in the decorating of fine china. In this case the producer plant is operated as an adjunct of the boiler plant—the boiler being operated also on anthracite rice. Unlike the bituminous producer, the anthracite operation is clean and favorably compares to boiler plant operation. There are no producer burnout periods since the gas is free of tarry substance.



Courtesy, The Wellman Engineering Co., New York, N. Y.

Fig. 13. Sulfur removal tank, anthracite gas.

The gas itself is somewhat comparable to bituminous producer gas, minus the illuminants; running around 27% CO, 16% H_2 and 50% N_2 with a gross BTU of about 150. The air required for combustion is only a little over 1 cu. ft. per cu. ft. of gas, as compared with more than 10 for natural gas, so the usual practice is to let the gas inspirate the air, although any of the usual types of gas burner equipment can be converted to anthracite gas. Fig. 14 shows the gas-burner end of 34 bakery ovens baking some 33 tons of food products per 12 hours.

Anywhere within reasonable shipping radius of the anthracite fields an installation of an anthracite producer, if it had been made about 10 years ago, could have paid for itself within a matter of two years, assuming an ordinary distance of haul for anthracite. Prices on the two usable grades have risen markedly as follows:

APPROXIMATE PRICE PER NET TON

Year	Rice	Barley
1930	$1.60	$1.20
1931-1935	1.85-2.25	1.40
1936	2.40	1.55
1937	2.65	1.80
1938-1941	2.75	2.00
1941-1943	2.90	2.15
1943	3.35	2.50
1944	3.85-4.30	2.85-3.30
1944-1945	3.75-4.30	2.75-3.05
1946	4.90	3.50
1947	5.00 +	

The price of anthracite fines is a variable quantity because of the drive to dispose of it in the form of steady

Courtesy, The Wellman Engineering Co., New York, N. Y.

Fig. 14. Large bakery ovens with anthracite gas.

customers and also the fact that it can be purchased in the warm months and stored. At the present time the cost of anthracite gas is generally a little on the lower side of natural gas where the two compete and considerably on the low side now of fuel oil at present prices.

However, the investment cost in such a plant is high, and such that one would never consider a Wellman-Galusha plant from the ground up for standby purposes. In other words, it would have to run all the time to be economical. It so happens that natural gas rates in some localities are such that it is actually the cheapest fuel of all for a given use. Therefore, it is desirable to be in a position to switch from one fuel to the other conveniently. On an economic basis and from the practical standpoint of availability, this ideal combination of the moment boils down to liquid No. 2 Fuel oil worked in combination with natural gas.

ANNUAL MEETING OF G.C.M.I. HELD AT WHITE SULPHUR SPRINGS

The Glass Container Manufacturers Institute held its annual meeting on May 3, 4 and 5 in the familiar surroundings of The Greenbrier at White Sulphur Springs, West Virginia. It was the first time since the Spring of 1940 that the glass container industry has been able to convene at this highly desirable meeting place and while the interior of The Greenbrier has taken on a new look, the glass men and their allied manufacturers seemed perfectly at home in their old stamping ground.

The meeting was called to order promptly at 10 A.M. on Monday, May 3, by Robert L. Warren, the Institute's President. Following Mr. Warren's opening remarks, the first report to be presented was that of the Committee on Labor Relations. Ralph A. Lind, Secretary of the Committee, delivered the report in the absence of Committee Chairman, Louis C. Roche.

Mr. Lind outlined the work of the Committee in keeping the entire membership informed regarding all important labor developments. He briefly related the results of recent meetings of the Committee and outlined joint conferences scheduled with the American Flint Glass Workers Union and the Glass Bottle Blowers Association. Mr. Lind stressed the importance of having every member company represented at these meetings.

In connection with union elections to determine the right of the unions to request inclusion of union shop provisions in contracts, the Labor Committee's report stated that Mr. Lind and Mr. Roche participated with Messrs. Lee Minton and Z. C. Wright of the Glass Bottle Blowers Association in a conference in Washington in March with attorneys for the National Labor Relations Board. Discussion at the meeting concentrated procedure which would have to be followed by the unions in establishing their right under the Labor-Management Relations Act of 1947 to bargain with the industry on the union shop feature.

Mr. Lind stated that since the last report of the Labor Committee, there have been practically no labor disputes or disturbances in any of the glass container companies.

In connection with the work of the Committee on Testing Procedures whose Chairman is W. Ronald Lester of Maryland Glass Corporation, Dr. Frank W. Preston outlined the accomplishments of the Committee and emphasized the importance of the various phases of the work.

Joseph C. Feagley of Armstrong Cork Company followed Dr. Preston with a brief outline of the activities of the Committee and reiterated the need for the continuation of its work.

Concerning the present status of the Committee's program, it was stated that the Empirical Impact Testing Work is only partially active due to the difficulty in locating an experimental engineer to act as Dr. Ghering's assistant and understudy. The program on Basic Impact Research is now inactive and the Cord Research Program has been terminated.

The activities of the Committee on Standards for Finishes were covered in a written report by its Chairman, C. C. Green of Armstrong Cork Company. Mr. Green's report included specific details concerning prints of glass finishes and explanatory bulletins issued by his Committee and pointed out that the reviewing and classification of old prints of Standards for Finishes developed by the former Glass Container Association are being concluded as rapidly as possible. It was pointed out that in pursuing this work, careful consideration is given to each finish so that the finish can be easily interpreted thereby insuring maximum efficiency in producing glass with marketable finishes.

With regard to the closure as it pertains to the work on finishes, it was stated that closure specifications applying to each finish are taken into consideration in order that the best possible glass and closure combination may be obtained. Thought is also given to the mold maker's and packer's problems in setting up finish specifications.

Traffic matters are as complex as ever and the work of the Traffic Committee has been made more arduous due to freight increases and shipping container regulations, various aspects of which are still in the process of negotiation.

Commenting on the report of the Traffic Committee which is headed by I. L. Dunnington of Anchor Hocking Glass Corporation, B. H. Taylor, Traffic Director of the G.C.M.I., stated that with regard to the last interim increase granted the railroads by the Interstate Commerce Commission, an increase of twenty per cent in all freight rates, while the final order in this proceeding was still pending at the time of the Traffic Committee's report, there was a possibility that it would be released in a reasonably short time. The foregoing increases are to be applied in lieu of a previously authorized increase of 20 per cent in all territories. Subsequent to the report of Chairman Dunnington, the Interstate Commerce Commission entered a third supplemental report and code in the proceedings before it involving increases in freight rates. Under this code, the railroads were granted authority to advance freight rates again. The percentage increase to be applied in all freight rates subject to certain maximum increases of specific amounts on some heavy moving commodities is as follows: With Eastern territory, 30 per cent; Southern territory, 25 per cent; Eastern section of Western territory, 25 per cent; Remaining section of Western territory, 20 per cent; interterritorially between Southern and Western territories and between these territories and Eastern territory, 25 per cent.

Other matters which were covered in the Committee's report to the Institute's membership were the effect of freight rate increases on Federal taxes paid by the consumer, the railroad tariff rule, known as Classification Rule #41, affecting the packaging of empty glass containers and products packed in glass and I.C.C. Dockets #28300 and #28310, which proceedings deal with the ultimate establishment of a uniform freight rating classification for application throughout the country and the publication of a single scale of class rates also for nation-wide application, except in Mountain-Pacific territory.

With regard to pending legislation in the Congress, there are two matters felt to be of considerable im-

portance. One contemplated piece of legislation concerns the creation of a bureau within the Interstate Commerce Commission which would handle freight car distribution. It is felt that the enactment of such a bill would, to a large extent, take this prerogative away from the railroads. The other pending legislation pertains to the establishment in the Executive Department at Cabinet level, a Department of Transportation. In connection with this idea, there is a general belief that such a bill might result in transportation being dealt with by the Federal Government in a political fashion.

J. M. Foster of Foster-Forbes Glass Company, as Chairman of the Committee on Container Design and Specifications, reported the work of his Committee during the last six months. He stated that the Committee and its Sub-Committees, those covering technical matters, beer bottles and milk bottles, have continued to make progress in providing drawings of container lines for which a definite need has been found. In connection with the revision of container drawings, in some instances it has been found desirable to make revisions in order to improve the item or the usefulness of the drawing. Several new drawings have been completed and adopted by the Committee and one drawing has been discontinued. A number of new projects are under way covering various types and sizes of glass containers for the packaging of many different products.

In concluding, Mr. Foster stated that his Committee hopes to continue in its endeavor to simplify container supply problems for the packer by making available specifications for container lines for which a definite need has been established.

The next Committee to make its report was the Committee on Package Design and Specifications whose Chairman is P. A. Parker of Anchor Hocking Glass Corporation. Since the last annual meeting, the Committee has been engaged in planning and directing the industry's long-range Carton Research and Development Program of which some of the studies have already been completed.

The Carton Research and Development Laboratory which the Institute has set up is located at Preston Laboratories, Butler, Pa. The laboratory proper is housed in an insulated room of dimensions approximately 30 x 15 x 10 feet. The atmosphere is conditioned to 50 $\pm$ 2 per cent relative humidity and 73 $\pm$ 3.5° F. temperature. These measures are necessary since nearly all physical and structural properties of paper and paperboard are profoundly influenced by moisture content. The moisture content of any given paper or paperboard depends upon the relative humidity and temperature of the atmosphere with which the paper or board is in equilibrium.

A preconditioning cabinet has been constructed in which the fibrous materials are dried below testing conditions so that when they are placed in the testing room, they will approach testing conditions from the dry side. A peculiar characteristic of celluosic material is that when it is stored at 85 per cent R.H. and then conditioned at 50 per cent R.H., it will have a different moisture content than if it were stored at 35 per cent R.H. and then conditioned at 50 per cent R.H. Therefore, test samples are preconditioned at approximately 35 per cent R.H. before they are conditioned and tested at 50 per cent R.H.

The S&S Sample Making Machine and the sample board stock are housed in a separate room. The sample machine is used to fabricate sample boxes for testing. It is equipped with a knife, scoring wheels, scoring bars and slotter attachments which enable the operator to fabricate almost any design or box which he may require.

The machine shop facilities of the Preston Laboratories are readily available for the construction, modification and repair of test instruments. Several box testing instruments have already been produced. The laboratory is equipped to conduct various tests on component materials and/or combined board and to conduct tests on the complete package.

The Committee report reviewed its problems and clearly defined the objectives and goals of the Carton Research and Development Program. Some progress has been made on each of the six objectives originally set up, the first of which was the development of more basic information on the materials used in the construction of fibre boxes. In all of the testing and development studies conducted at the laboratory, an effort is being made to identify and evaluate all of the materials used in the construction of the test boxes.

Several of the studies have developed improved methods for evaluating the serviceability of fibre boxes and protective inner packing. Statistical methods have been employed in studying the variables of the testing instruments and testing methods, as well as several new box testing methods and techniques.

The Committee has continued its activity of formulating recommendations to rail carriers on Classification Rule 41 matters affecting the packaging of glass containers. Another broad objective has been the development of information for use in the consideration of standards for fibre boxes and inner packing methods and of information suitable for use in advising the glass packers on specific packaging problems.

In his report of the activities of the Technical Committee on Glass Packed Products, John M. Scharf of Armstrong Cork Company, Committee Chairman, stated that two extensive meetings have been held since his last report. At one of the meetings, the Fellowship work at the University of Massachusetts was reviewed and future activity was outlined. At the same meeting, the processing studies being investigated in cooperation with the National Canners Association and other participating laboratories were discussed with respect to the ideal standards for processing. At a later meeting with the same Committee members, there was a furtherance of the studies made and discussion of laboratory evidence with a view to ultimate publication of the standards. Another such meeting in the very near future is contemplated and perhaps a meeting with retort and instrument manufacturers for a final review of mechanical detail standards.

Mr. L. F. Gayner, of Gayner Glass Works and Chairman of the Committee on Government-Industry Relations, was the next member to give a report on his Committee's activities. He outlined the results of a meeting held in January at the request of the Office of Materials Distribution of representatives of the metal cap and crown industries. The meeting was held to discuss proposed restrictions in the use of tinplate. In this connection, Mr. Gayner made mention of the extension until

(*Continued on page* 346)

THE GLASS DIVISION HOLDS TWENTY-NINTH ANNUAL MEETING DURING A. C. S. JUBILEE

The American Ceramic Society, after an interval of nine years, returned to Chicago to celebrate a Golden Anniversary (something that happens once in a 50-year period, or, as an ancient Latin Keramist once said, "annus mirabilis"). During the period of April 25 to 30, the wind in the Windy City not only became hot, it also became saturated with silica dust, spray booth carry-over, fumes from 9-inch rails and, according to the titles of some of the Glass Division papers, with radio-activity.

The registration was in the "upper register" (1877 by official count, the largest registration in the history of the Society), the Jubilee Jamboree was justly jammed and the Banquet attendance reminded one of "Bank Night at the Bijou". In spite of the Empire Room, the Pump Room, The Glass Hat and the 606 Club, much serious business was transacted.

In the case of the Society as a whole, time was found to swear in the following as the guiding hands of the Society for the coming year: President, John W. Whittemore, Virginia Polytechnic Institute, Blacksburg, Va.; Vice President, H. M. Kraner, Research Department of Bethlehem Steel Company, Bethlehem, Pa.; Treasurer, W. E. Cramer, Industrial Ceramic Products, Inc., Columbus, Ohio; and Secretary, Charles S. Pearce, American Ceramic Society, Columbus, Ohio. In addition, sufficient "time out" was taken to induct the following Fellows, three of which are Glass Division members: Clarence L. Babcock, Owens-Illinois Glass Company, Toledo, Ohio; George C. Betz, Metal & Thermit Corporation, New York, N. Y.; A. Curtis Jackson, Claycraft Co., Columbus, Ohio; Clarence A. Hahner, National Bureau of Standards, Washington, D. C.; Edward P. McNamara, Shenango Pottery Co., New Castle, Pa.; Earl C. Petrie, North American Refractories Co., Cleveland, Ohio; Rolland C. Roup, Globe-Union, Inc., Milwaukee, Wisc.; Charles S. Pearce, American Ceramic Society; William B. Silverman, Owens-Illinois Glass Co., Toledo, Ohio; and Carl H. Zwermann, formerly at University of Washington, Seattle.

Turning to the Glass Division meetings and activities, a "new innovation was innovated", the meetings being run in the fashion of a relay race with Chairman R. F. Brenner of Anchor Hocking Glass Corporation handing the baton at the finish of the first lap over to Vice-Chairman H. R. Lillie of Corning Glass Works for the running of the second lap. Mr. Lillie, at the end of the second lap, turned the baton over to Vice-Chairman Elect C. H. Hahner of the National Bureau of Standards. Finally, the Anchor Hocking man got it back for the last lap. This relay team proved so successful that the Division finished its program and sessions ahead of schedule, something that has been rarely done before.

The first four papers presented before the Division took the audience on a radiation tour from X-rays up to the infrared. J. A. Kapnicky and W. A. Koehler of West Virginia University and a new-comer to the Glass Division, outlined the effect of cerium oxide on the spectral transmissions of some experimental glasses, including soda-lime-silica, borosilicate and lead-silicate types. The transmission curves shown substantiated, in general, what was already known regarding ultra-violet cut off, but inasmuch as the prime interest of the paper was to investigate the use of cerium oxide as an oxidizing agent and decolorizer, the visible region of the curves seemed to offer little help inasmuch as the iron content of the glasses used was not systematically varied. One can get too "complex" about this sort of thing. J. M. Florence, F. W. Glaze and C. H. Hahner of the Glass Section of the Bureau of Standards, now that their chemical supply room is again well stocked, jump from two-component to three-component glasses and find that out of various combinations of SiO_2 with Li_2O, Na_2O, K_2O, CaO, SrO, BaO and PbO (what, no Mgo or Zno?), if one wishes to get away from that water band absorption of infrared, they better concentrate on BaO.

F. Britt of Corning Glass Works (transmission changes under ionizing radiation) shocked a lot of glasses by exposing them—to X-rays, of course.

J. L. Rotherman, Kuan-Han Sun and A. Silverman take care of the X-ray technician, and might possibly be working up to atomic bomb radiation protection, by developing thinner thickness glasses with greater absorptions.

After all these invisible radiations, E. C. Hagedorn showed the Division what the ultimate fate is of those beautiful specimens obtained in the temperature gradient method of studying devitrification. While many glass technologists have wondered how to dispose of such platinum boat-shaped samples of glass, Mr. Hagedorn put them under his microcamera and produced many visual things and objects that the average petrographer never sees but often dreams about.

The National Bureau of Standards, just to show their diversity after an infrared absorption paper, had G. F. Rynders, O. H. Graner and D. Hubbard take care of the topic "Electrode Function (pH Response) of Soda-Lime-Silica Glasses". Water Glass manufacturers shouldn't worry too much. The amount of electrode business is much too small, the glasses are not too good and, of course, the work in the main was to prove and verify basic theory. Way on the other side, i.e. development of new optical glasses, E. H. Hamilton, O. H. Graner, G. W. Gleek and C. H. Hahner spent a little time sticking La_2O into barium crown optical glasses along with other things and came up with some improvements, and also some disadvantages.

After watching the Bolero performed the night before, A. Silverman's slide lecture wasn't too bad to wake up to. The many colored slides shown presented quite visually the progress that the glass industry has made, both mechanical and technical, over the past several years. Varga and Moran and their pin-up girls contributed quite a bit to the presentation of such advances.

J. P. Poole, D. P. Enright and P. A. Marshall, Jr., of Pennsylvania State College, became technical and proved that many of the major ingredients and many of the minor ingredients used in flint and amber glasses

actually did what they were supposed to do. Of course, this work was conducted under controlled conditions; no coal strikes, no lack of box cars and none of the other etc., that makes life hard for the plant technologist. Moore and Lyle, following up the above paper, showed by mathematics that you can make radical batch changes and also if you use their equation, you can expect cordy glass sometime during the life of the furnace.

Now that we are living in an age of radioactive isotopes, there is no reason to believe that their use should be confined to breakfast foods. J. R. Johnson not only gave a brief summary on the how and why of such things, but also gave a list of the materials available and the various methods by which they could be utilized. S. A. Lindroth of the University of Illinois presented pertinent data obtained from emanation studies (radiothorium nitrate was used) and showed that such data could be utilized in studies of surface determinations, surface changes (melting) and diffusion studies. Both of these papers indicated great possibilities for the use of radioactive materials in both theoretical and practical studies of glass problems. However, it is going to make it tough for the glass technologists to learn about half-life and millicuries (one millicurie= 3.7 by 10^7 disintergrations per second).

Several papers came from the laboratory of Glass Science, Inc. at Pennsylvania State College, brought by both Professor W. A. Weyl and by his students. Actually, Pennsylvania State contributed five papers out of twenty-one. Professor Weyl, working on physical chemical principals, stuck various ions onto and into the glass surface and changed everything. Following up the work of the Professor, Marboe and Smiley, with Weyl, used his data to prevent glass from sticking to expensive type crucibles. Poole reported on the results of low temperature viscosities of alkali-silicate glasses and then moved over to the Department of Mineral Technology where he collaborated with M. Zensamer on a systematic study of the effect of oxide constituents (soda, potash, calcia, magnesia, strontia, baria and alumina) on the low temperature viscosity of silicate glasses.

F. B. Hodgon, D. A. Stuart and F. E. Bjorklund, University of Utah, another new-comer to the Glass Division, took a lot of F. W. Preston's data, worked it over and over and finally found that Eyring's process theory would make a nice curve. Preston, if asked, will admit that his data will even fit the life expectancy curves.

Armstrong Cork Company with F. R. Matson on "high humidity" and K. C. Lyon on "high humidity with mineral salts for split seconds", not only gave a lead to an accelerated weathering test with comments about the roles of various oxides, but also showed that you can improve durability testing by rinsing out the ware with water from the Red Sea (does copper make it red?).

The preceding account takes care of the papers on the program, but the Glass Division also had a luncheon, the highlight of which were Toolmaster Scholes introducing "Friar Tuck" (Tuckerman or "Strain Gage Tuckerman" of the National Bureau of Standards), who in turn gave a background introduction (which, in the light of today's headlines sounded like the U.N., the man being so well travelled) of a certain individual who for years has contributed much basic knowledge to the science of glass technology. In spite of a certain pun, "Q" stands for a sore throat, the name with the Q given and the Q acquired, namely A. Q. Tool of the National Bureau of Standards was presented on behalf of the members of the Glass Division with a very handsome timepiece.

The Glass Division also held a business meeting, reports were made by A. E. Pavlish of the Membership Committee, H. H. Holscher of the Nomenclature Committee, by C. H. Hahner for H. H. Blau on Research and by S. R. Scholes on Rules. J. C. Hostetter brought up the International Congress and the subject of translating certain foreign glass journals was discussed. Inasmuch as a stenographer was present at this business meeting, the pro's and con's, along with the subject, will be published. The official election for officers of the Glass Division for the year 1948-1949 showed that H. R. Lillie of Corning Glass Works would be Chairman, C. H. Hahner of the National Bureau of Standards would be Vice-Chairman and that F. V. Tooley of the University of Illinois would be Secretary. To Sam Scholes: Adieu, Adieu, and many thanks!

Brief summaries of some of the papers presented before the Glass Division follow:

Effects of Cerium Oxide on Spectral Transmission of Some Experimental Glasses. *By J. A. Kapnicky and W. A. Koehler, West Virginia University, Morgantown, W. Va.*

The purpose of this investigation was to supplement the known facts concerning the effects of using cerium oxide as a glass constituent, paying special attention to its effects on spectral transmission.

Three types of glasses were prepared, namely soda-lime, borosilicate crown and ordinary flint (lead) glass, by melting batches in clay crucibles in a gas fired furnace. The ceria content was varied by adding increasing amounts of cerium oxide to these base glasses. The spectral transmission of polished glass samples was measured by means of a Beckman quartz photoelectric spectrophotometer over the range of 250 to 1000 millimicrons. All curves so obtained were calculated to a thickness of 2 mm. by means of Sharp's graphical method.

From the curves obtained from the various glasses, it was concluded that increasing amounts of cerium oxide in the soda-lime glasses used caused a proportionately greater absorption of wave length up to about 380 millimicrons. There was also a marked decrease in the absorption of wave lengths from 550 up to 1000 millimicrons. The addition of increasing amounts of ceria to the borosilicate glasses caused a greater absorption of wave lengths up to about 550 millimicrons. There was a decrease in the absorption in the range from 600 to 1000 millimicrons.

Cerium oxide, when used as a constituent in the lead flint glasses, caused a greater absorption in the ultraviolet range. The flint glass (lead) containing the least amount of cerium oxide showed less absorption of wave lengths from 400 to 1000 millimicrons than did the flint glass (lead) which contained no cerium oxide. The flint glass (lead) containing the greatest amount of cerium oxide showed a greater absorption of wave lengths up to 550 millimicrons. All of the flint glasses (lead) containing cerium oxide exhibited less absorption of wave lengths from 550 to 1000 millimicrons than the flint glass (lead) which contained no cerium oxide.

Transmittance of Near Infrared Energy by Some Three-Component Glasses. *By J. M. Florence, F. W. Glaze, and C. H. Hahner, National Bureau of Standards, Washington 25, D. C.*

Three-component glasses were prepared containing silica and two of the following oxides: Li_2O, Na_2O, K_2O, CaO, SiO_2, BaO, and PbO. The transmittances of these glasses for infrared energy at wave lengths 0.8 to 6.0 microns were measured.

Such glasses, containing lead oxide as a component in quantities less than 50 percent by weight, are efficient for

the transmittance of infrared energy for wave lengths from 0.8 to 4.5 microns.

Glasses prepared from the lead-oxide-barium oxide-silica system have a high transmittance of infrared energy at the wave length of 2.8 microns. This improvement in transmissivity is believed to be caused by the lower water content of barium glasses.

Glasses containing alkaline earths are efficient for the transmittance of infrared energy for wave lengths from 2.5 to 4.5 microns.

TABLE 1.

Batch compositions of glasses having a high transmittance of infrared energy.

Glass	SiO_2		Li_2O		Na_2O		K_2O		PbO		CaO		BaO	
No.	Wt	Mol	Wt	Mol	Wt	Mol	Wt	Mol	Wt	Mol	Wt	Mol	Wt	Mol
C-258	40.0	64.2							10.0	4.3			50.0	31.5
C-274	40.0	66.9							30.0	13.5			30.0	19.6
C-322	54.2	71.4	5.4	14.3					40.4	14.3				
C-325	51.3	71.4			10.6	14.3			38.1	14.3				
C-327	48.6	71.4					15.3	14.3	36.1	14.3				
C-363	34.8	50.1									13.5	20.8	51.7	29.1

New Glasses for Absorption of Harmful Radiations. *By J. J. Rothermel, Kuan-Han Sun and Alexander Silverman, (Rothermel and Silverman, University of Pittsburgh; Sun, Westinghouse Electric Corporation, East Pittsburgh, Pa.).*

The addition of elements not previously used has made it possible to produce new glasses having higher absorption for harmful X-radiation than those now available. The older glasses for absorbing X-rays had to be of a thickness approximately 3.5 times that of a lead shield. These new glasses which have been developed by Rothermel, Sun and Silverman will effect the same absorption with a thickness of only 1.7 times that of a lead shield. The old X-ray absorbing glasses upon exposure to X-rays, for example, 200 kilowatt hours at a distance of about an inch and a half to two inches, will discolor badly and will finally turn brown in color. It was stated that these new glasses are unaffected and will retain their original color.

Photographic Report of Some Crystalline Phases Found in Soda-Lime-Silica Glasses. *By E. C. Hagedorn, General Research Laboratory, Owens-Illinois Glass Co., Toledo, Ohio.*

Using some very excellent microphotographs, the author described certain crystal forms and peculiarities not commonly found in the "glass stone" or petrographic literature. The source of each crystalline phase described was the sample of glass on which a liquidus determination had been made by the temperature gradient method. Many of the photomicrographs shown were taken from that portion of the sample which was near the liquidus temperature. In fact, some present the equilibrium conditions of crystalline solid and liquid. The various crystalline phases shown included the following, tridymite, cristobalite, devitrite, wollastonite, pseudowollastonite and diopside. The compositions of the glasses in which these phases occurred were also given.

Inasmuch as each microphotograph (48 in all) had its own story, it is impossible to summarize this report. It is a valuable addition to the literature and its early publication will be looked forward to by those interested in this type of work.

Electrode Function (pH Response) of the Soda-Silica Glasses. *By Gerald F. Rynders, Oscar H. Grauer, and Donald Hubbard, National Bureau of Standards, Washington 25, D. C.*

For a glass to function satisfactorily as a glass electrode it must have a uniform durability over an extended pH range as well as an adequate hygroscopic nature. It has been shown that where the glass is attacked excessively or where the glass has an inadequate hygroscopicity, departures from the theoretical dictates of the Nernst equation occur. These departures at times have been attributed to specific equilibrative responses to ions other than hydrogen. To obtain more information on these subjects, a series of glasses of the soda-silica system were studied in continuation of the work done on potash-silica glasses.

Ten glasses from 55 percent to 91 percent of silica were melted in platinum. Hygroscopicity and durability measurements were compared with the electrode function and the apparent pNa response of glass electrodes made from glasses of this series.

From the values of the water adsorbed and the chemical durability (by an interferometer procedure), it was expected that a glass of 86 percent of silica and 14 percent of soda would provide the correct response. However, as a result of devitrification, electrodes were not made.

All glasses made were quite hygroscopic and it is of interest that the hygroscopicity data could be plotted such that changes in slope occurred at points which are significant in the phase diagram of the system.

The durability characteristics of the glasses at pH 4.6 could be grouped into three classes 11) the region in which the glasses were readily soluble, 2) the region in which swelling and differential solution of the components in the glass takes place, and 3) the region in which no visible effects were observed.

The electrode function of the glasses of very high hygroscopicity and poor durability gave departures approaching the values of the calomel half cell and a punctured electrode made from Corning 015. From the effort to attribute these departures to a response to pNa, it was concluded that the values found were not compatible with this interpretation.

Changes in Refractive Indices and Liquids of a Dense Barium Crown Glass Containing Lanthanium Oxide Produced by Partial Substitution of Some Oxides. *By Edgar H. Hamilton, Oscar H. Grauer, Given W. Cleek and Clarence H. Hahner, National Bureau of Standards, Washington 25, D. C.*

The addition of La_2O_3 to barium crown glasses is desirable for the production of glasses of high indices of refraction and low dispersion. However, increasing the La_2O_3 content in the glass above 6 mole percent leads to glasses that have high liquidus temperatures and that devitrify readily. A glass of the following composition in mole percent: SiO_2—28, B_2O_3—28, BaO—26, BeO—6, and La_2O_3—12, with $M_D = 1.7148$, $\upsilon = 52.7$, and liquidus = 1156°C, could not be cooled in slabs of 1″ thickness without divitrification setting in.

It was felt that the devitrifying tendency of the glass could be diminished by the introduction of other oxides. Al_2O_3, ZnO, CaO, SrO, Ta_2O_5, ZrO_2, or ThO_2 was substituted for BaO, SiO_2, or La_2O_3 on a mole for mole basis. All melts were made in platinum crucibles and stirred with platinum —10% rhodium stirrers. Each glass was annealed from a temperature known to be above its critical temperature.

Al_2O_3 raised the liquidus temperature and increased the tendency of the glass to devitrify.

CaO and SrO lowered the n_D of the glass. Glasses containing less of these oxides than the compositions having the minimum liquidus temperature were definitely improved with regard to ease of melting and the production of homogeneous glasses. ZnO had very little effect on the properties of the base glass. Ta_2O_5 in amounts up to 3 mole percent lowered the liquidus temperature of the base glass and appeared to aid in producing homogeneous glass. ZrO_2 had very little effect on the liquidus temperature of the glass, but appeared to reduce the tendency of the glass to devitrify. Three series of melts indicated that 4 mole percent of ThO_2 is the optimum concentration of this oxide in the range of glasses studied. With a base glass containing 4 mole percent ThO_2, a minimum was found in the liquidus curve when 3 mole percent La_2O_3 was substituted for BaO. High quality optical glass has been produced containing approximately 7 mole per cent La_2O_3 and 4 mole percent ThO_2. This glass has an n_D of 1.7043 and υ value of 54.0.

The above conclusions on the effect of the various oxides as to the base of obtaining homogeneous glasses free from crystallized materials and striae are quite qualitative, being subject to the bias of the observer and apply only to the range of glasses covered in this investigation.

Some Recent Developments in American Glass Manufacture: III, 1938-1947. *By Alexander Silverman, University of Pittsburgh, Pittsburgh, Pa.*

This item on the Glass Division program could not be called anything but a "Technolog". Professor Silverman by the means of color slides gave a "sequence in stills" on the progress of glass technology and manufacturing over the last ten years (there was some overlapping, of course). Quite a few slides were shown and the running commentary followed the story that Professor Silverman gave before the Eleventh International Congress of Pure and Applied Chemistry, London, England, July 17 to 24, 1927. This has been reprinted in the *Bulletin of the American Ceramic Society*, Vol. 26, No. 11, November 15, 1947.

The Effects of the Major and Some of the Minor Constituents on Glass Melting. *By Dorothy P. Enright, Paul A. Marshall, Jr., and James P. Poole, Pennsylvania State College, State College, Pa.*

The effects of the major and some of the minor constituents on the meltability and fining characteristics of amber and flint container glasses are discussed in this paper. The constituents investigated were silica, alumina, lime, magnesia, soda, fluorine, barium oxide and sulfates. The effects were measured by seed count, visual analysis, and determination of density and low temperature viscosity characteristics. Curves of fining time and low-temperature viscosity data are presented. Details of melting and testing procedures are given. The testing procedures were unique in that forty-pound melts were made and the results were found to be applicable to the operation of continuous glass tanks.

The following general conclusions summarize the experimental data presented in the paper.

An increase in silica increased the melting and fining time, scumming tendency and viscosity of the glass, but decreased or increased the seed count depending on the type of substitution.

Many of the properties of the glass influenced by alumina passed through a reversal with increasing amounts of alumina. Above 2.3% alumina the melting and fining rates were considerably decreased.

When lime was substituted for silica, slight changes were noted in the fining and scumming characteristics of the glass. When used to replace soda, the viscosity was increased. Changes in lime content showed less effect than any other oxide on the melting and fining properties of the glass.

The substitution of magnesia for lime shortened the fining time, but increased the scumming tendency. Magnesia decreased the viscosity of the glass at low temperatures.

An increase in soda greatly improved the meltability, fining and scumming properties of a glass. Soda decreased the viscosity at all temperatures, but was most effective at low temperatures.

Fluorine decreased the fining time of a glass but increased the tendency to scum. The viscosity of the glass was decreased by addition of fluorine.

Sulfates decreased the tendency of a glass to scum and improved the fining properties.

Barium oxide had its greatest beneficial effects below 2650°F. At low temperatures barium oxide decreased the fining time of a glass; however, at high temperatures the decrease was very small. The substitution of barium oxide for silica slightly reduced the viscosity of the glass at low temperatures; when substituted for magnesia or lime a greater decrease was noted. Barium oxide was most effective when substituted for lime or magnesia.

Some Examples of Radioactive Tracing in Glass Technology. *By Stig A. Lindroth, Department of Ceramic Engineering, University of Illinois, Urbana, Illinois.*

In 1929, Hahn suggested the use of radioactive emanation-producing tracers for investigations of powders. The method has been applied in 1) determination of surfaces and surface changes (e.g., melting) and 2) the study of diffusion phenonema in relation to transformations and chemical reactions. Briefly, this emanation method is based on the following principle: to the substance to be tested, a radio active, emanation delivering element is added. A certain fraction, defined as the "emanation ability", of the emanation formed in the sample will be released from the surface to an extent that depends on 1) the surface condition: the bigger the surface, the greater the chance for an emanation atom recoiling in the body of the sample to reach the surface; 2) the inner structure: governing the diffusion of the emanation formed. The amount of liberated emotion atoms is measured by means of their ionizing ability.

Preliminary investigations on glass batches, started at Chalmers Technical University, Gothenburg, Sweden, have indicated the usefulness of the method. In this application of the procedure, small samples of glass batch (0.2 gm.) were treated with radiothorium nitrate solution dried and sieved, and heated at a constant rate of 10°C. per min. up to 900°-1000°. The release of thorium emanation atoms as a function of the temperature is measured by their ionizing effect on a nitrogen current passing the sample into an ionization chamber connected to an amplifier and a sensitive galvanometer.

The method has been used in the study of 1) sodium carbonate, calcium carbonate, and a soda-lime-silica glass batch; the melting point of Na_2CO_3, the aragonite-calcite transformation, and the dissociation of $CaCO_3$ are clearly brought out; the emanation curve of the glass batch shows also the melting point of Na_2CO_3 referring probably to isolated grains of this compound; and 2) influence of minor constituents (0.5 and 3%) on the melting rate of the glass batch mentioned. The temperature of minimum emanation release, assumed to define the melting rate, is, for instance, decreased 100°C. by NaCl.

Surface Properties of Glasses as Affected by Heavy Metal Ions. *By W. A. Weyl, Pennsylvania State College, State College, Pa.*

Up to the present time it has not been possible to explain the difference which exists between heavy metal ions such as Pb^{2+} and noble-gas-like ions of the same size and charge. So far as size and charge is concerned Pb^{2+} and Sr^{2+} are practically identical. Their electronic structures, however, are basically different. Whereas Sr^{2+} has eight outer electrons (structure of the inert gas krypton) the Pb^{2+} has two outer electrons. The usual methods for estimating the forces acting between one of these ions and oxygen fail to bring out their differences. The ionic potential of these cations as well as the bond strength calculated from the dissociation energy PbO and SrO do not reveal major differences. Practical experience and laboratory studies, however, bring out the fact that the two oxides have little in common with respect to their influence upon the properties of a glass.

K. Fajans and N. J. Kreidl explained this discrepancy on the basis of the difference which exists in the polarizability of the two ions. This paper discusses the polarization or deformation of ions and expresses them in terms of chemical affinity. The difference between a Pb^{2+} or a Sn^{2+} ion and a noble-gas-like ion of a comparable charge and size is not due to a difference in the overall forces, but results from the formation of strongly asymmetrical groups when heavy metal ions are exposed to the negative field of O^{2-}. The field of force surrounding a noble-gas-like ion remains more symmetrical because the octet shell cannot be distorted to the same extent as an incomplete outer electronic shell.

The deformation of ions and the formation of asymmetrical groups in glasses produces structural units comparable with capillary-active groups in aqueous solutions. These groups accumulate in the surface layer where they lower the surface tension. As a result, the ionic forces emanating from such a surface layer are decreased. Glass surfaces containing these units decrease natural hygroscopicity.

Since friction between two glasses is partly the result of the chemical forces, the presence of these asymmetrical groups decreases the friction coefficient. In connection with friction, such a surface is less likely to build up electrostatic charges (friction electricity).

Some Adhesion Phenomena Involving Glasses, Metals and Fused Salts. *By E. C. Marboe, W. D. Smiley, and W. A.*

Weyl, Glass Science Research Foundation, State College, Pa.

Many fused salts and glasses adhere tenaciously to the platinum crucibel or glazed porcelain container in which they were melted; others fall out in one piece on tapping the crucible. The authors, using the theoretical concepts expounded by Weyl in paper #13, explain certain phenomema involving the adhesion of molten salts and glasses to metal and to the walls of a glazed crucible. The nature of the forces between ionic materials and metals was briefly discussed. The formation of capillary-active groups in glasses can prevent the melts from adhering to the wall of the crucible. It was shown, in conclusion, that combinations of certain alkali halides with heavy metal ions are an efficient means of preventing adhesion.

Hygroscopicity of Soda-Lime-Silica Container Glasses. *By F. R. Matson, Research Laboratories, Armstrong Cork Company, Lancaster, Pa.*

Hubbard, working with optical glasses, found that the measurement of the hygroscopicity of powdered samples could be used as a means of evaluating the serviceability (i.e., as far as atmospheric chemical attack or weathering is concerned) and that the results so obtained gave a truer picture than results obtained from chemical durability methods in which the extractable alkali is used as a measure of weathering resistance.

Matson has developed a test procedure based on that proposed by Hubbard and has tested an extensive series of soda-lime-silica glasses of known composition in an attempt to see whether or not such a procedure could be used as a rapid-weathering test. In brief, the experimental procedure is as follows: one gram samples of dried powdered glass that have passed through a 200-mesh sieve are placed in uncovered low-form weighing bottles and exposed in a humidity cabinet for three days at 100°F., 98% R.H. They are then reweighed. The hygroscopicity value is expressed as per cent gain in weight. Samples are then dried at 120°C. for 24 hours and again weighed to determine their permanent gain in weight. The powdered glasses can be examined under a petrographic microscope for evidence and determination of weathering products. As a result of the experiments made by this procedure and using glasses of varied composition, the author concludes after a presentation of his data that container glasses of reasonably good powder test durability gain up to about 0.60 per cent in weight by his humidity method. Other glasses may gain as much as 1.7 per cent. There is direct correlation between powder test durability and hygroscopicity tests for glasses containing less than 18 per cent or less Na_2O. The composition factor affecting durability is, for simple soda-dolomitic lime-silica glasses higher in soda. An increase in CaO·MgO at the expense of SiO_2 will increase the hygroscopicity but will have little effect on the powder durability. The compositional factors affecting hygroscopicity are 1) Na_2O—Al_2O_3 ratio. Na_2O increases, while Al_2O_3 decreases the hygroscopicity. 2) Straight lime glasses are more hygroscopic than those made with dolomitic lime when the rest of the composition is the same in both glasses. Lime glass shows weathering more rapidly than the dolomitic lime type of the same composition and has a greater permanent gain in weight. 3) B_2O_3 reduces hygroscopicity. 4) $BaSO_4$ reduces hygroscopicity. This action may be chiefly due to the SO_3 which can cause greater volatilization of Na_2O and added corrosive action resulting in increased Al_2O_3 in the glass. This change is Na_2O and Al_2O_3 would reduce the hygroscopocity.

Effect of Rinsing on Chemical Durability of a Container Glass. *By K. C. Lyon, Research Laboratories, Armstrong Cork Co., Lancaster, Pa.*

That the chemical durability of a glass surface can be improved by treating it when hot with certain vapors is well known. It is also known that there is a difference in absorption on a glass surface of different ions from solutions and that certain ions tend to improve the chemical durability resistance when present in the glass or when present in the extraction water. The purpose of this investigation, therefore, was to determine if the chemical durability could also be improved by rinsing the glass surface with a dilute solution of various common inorganic salts.

New, run of the lehr, 4 and 8 ounce capacity, standard prescription shape bottles were used as samples. The bottles were treated by placing about 50cc. of the desired rinsing material in each, rolling three or four times by hand to get complete wetting of the inner surface, after which they were emptied, drained and inverted for about 5 minutes. All bottles were rinsed three times with doubly distilled water before being subjected to the autoclave treatment which was the usual one hour at 121°C. test procedure.

From the results obtained, it was concluded that the precision of the results did not justify a detailed conclusion as to the action of any specific solution with respect to any other, many of the treatments being no more effective than a water rinse. Of the various ions used, copper seemed to have the most pronounced effect.

Low-Temperature Viscosity of Alkali-Silicate Glasses. *By James P. Poole, Pennsylvania State College, State College, Pa.*

Using an improved technique, precision measurements of the viscosity of sodium, potassium, and sodium-potassium silicate glasses containing 10 to 40% (molar) alkali were made between the limits of 10^8 to 10^{14} poises. The measurements were carried out by the fiber elongation method with an error of less than 1%. The composition of all glasses studied was determined by chemical analyses.

It was found that the temperature coefficient of viscosity is nearly equal for the sodium and potassium-silicate binary glasses.

A log viscosity isokom plot of temperature vs. alkali content yields an S shaped curve for both the binary glasses. In the case of the soda-silica system, the inflections occur at about 25 and 35% (molar) soda while in the case of the potash-silica system, the inflections are found at 18 and 28 mol % potash. This would indicate that the breaks in the log viscosity isokoms do not depend on some definite $\frac{\text{alkali}}{\text{silica}}$ ratio. Between 18 to 28 mol % alkali, a soda-silica glass had a lower viscosity at a given temperature than the corresponding potash glass while above and below these concentrations, the potash glass is less viscous than the equivalent soda glass.

The viscosity of glasses reaches minima for certain glasses containing both soda and potash and the temperature coefficient of viscosity becomes considerably smaller for those ternary glasses. The maximum deviation from additivity is achieved when only 30% of the soda has been replaced by potash. An appreciable change in the viscosity characteristics of the glass resulted when only 5 to 10% had been replaced. These conditions may explain the practical advantages of certain glasses containing both soda and potash.

A Systematic Study of the Effect of Oxide Constituents on the Viscosity of Silicate Glasses. *By James P. Poole and Maxwell Gensamer, Pennsylvania State College, State College, Pa.*

The viscosity characteristics of glasses which were varied systematically from a simple binary soda-silica base glass by the substitution of molar quantities of Na_2o, CaO, MgO, SrO, BaO, and Al_2O_3 for SiO_2 and for each other were determined by the fiber elongation method between the limits of 10^8 to 10^{14} poises. Substitution was carried out as far as possible in all glasses until devitrification resulted. Compositions of all glasses studied were determined by chemical analyses.

The experimental results were presented graphically in two types of curves: 1) in which the logarithm of the viscosity was plotted against the reciprocal of the absolute temperature, 2) in which the change in the reciprocal of the absolute temperature was plotted against the concentration of the variable constituent at a constant viscosity.

When the alkaline earths CaO and MgO were substituted molecularly for Na_2O and the resulting viscosity changes

(*Continued on page 350*)

OUTLOOK FOR SODA ASH IN THE GLASS INDUSTRY

By MELVIN E. CLARK, Sales Mgr. for Heavy Chemicals
Wyandotte Chemicals Corp., Wyandotte, Mich.

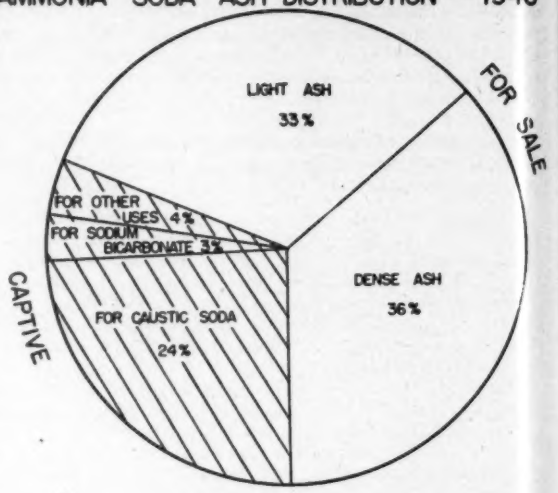
In the glass industry, as in the chemical industry, and in all our economy, these are uncertain times. The best evidence of that statement is that a paper on the soda ash supply situation should appear on the program of such an important conference of glass manufacturers. For 25 years prior to 1944 the glass maker was never seriously concerned about obtaining sufficient supplies of alkali. Most of today's large glass plants were built without much storage capacity for soda ash because of the superlative delivery service received and expected from alkali producers.

Today glass production is at an all-time high. Soda ash production also is at record levels. Yet consumers are demanding more glass products, and during recent years soda ash has literally been a "bottleneck" in meeting this peak demand. It is the purpose of this paper to describe how this situation came about and what is being done to rectify it. As to the future, the alkali producer is not in too good a position to forecast. Actually he should be *asking* glass people, rather than *telling* them about the outlook, because soda ash trends follow glass production very closely. If the glass industry could provide an accurate forecast of 1948 production, alkali producers could give a better forecast of soda ash availability. But there are as many different answers to that question as the number of people asked. Therefore, the author must limit himself to the results of his own market research, expressing merely the best opinion of his company at this time. It should be remembered that the picture presented here is as it appears on December 5, 1947. Six months from now or a year from now, the story might be changed by the shifting tides of human endeavor. Furthermore, our knowledge of the overall industry expansion is somewhat sketchy because we have no direct source of information on competitive activities. But the figures we will present are industry figures based on government data. We have been assisted in filling in the gaps by estimates from our customers, gathered through our sales organization. For the purposes of discussion, let us divide our statistical presentation into four parts:

1. The Soda Ash Market
2. The Relation between Soda Ash and Glass
3. Glass and Soda Ash related to our National Economy
4. The Forecast

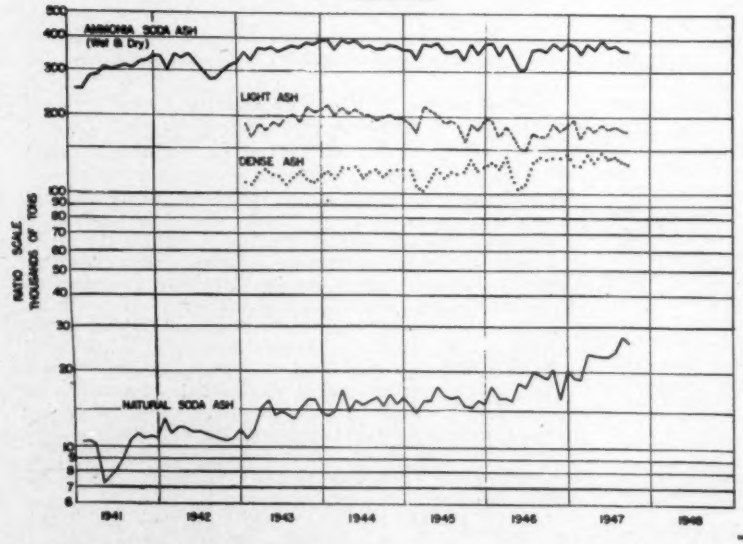
Presented before the Ninth Conference on Glass Problems, University of Illinois, Urbana, Illinois.

FIG. 2
AMMONIA SODA ASH DISTRIBUTION — 1946



CALCULATED BY MARKET RESEARCH DEPT., WYANDOTTE CHEMICALS CORP. BASED ON U.S. CENSUS BUREAU DATA

FIG. 1
CURRENT SODA ASH PRODUCTION
MONTHLY



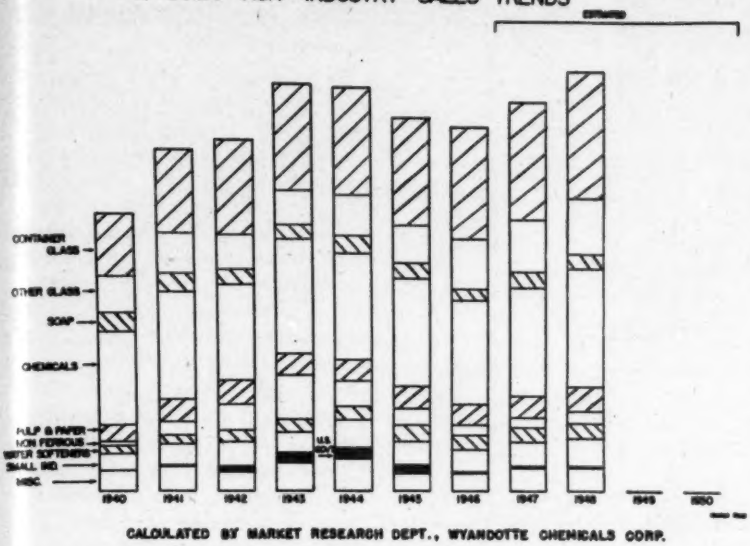
SOURCE: U.S. CENSUS BUREAU

The Soda Ash Market

First let us get a broad picture of this product by analyzing statistics on production. Soda ash is an industrial chemical second only to sulphuric acid in tonnage, the annual production totalling more than 4½ million tons. The value of production is about 90 million dollars. There are ten plants producing soda ash from salt by the ammoniæ soda process and five plants extracting soda ash from mineral deposits.

FIG.3

SODA ASH INDUSTRY SALES TRENDS



CALCULATED BY MARKET RESEARCH DEPT., WYANDOTTE CHEMICALS CORP.

Production data are published monthly by the Bureau of the Census and these statistics have been charted since 1941. Ammonia soda ash is shown in total and broken down into "finished light" and "finished dense". Natural soda ash (only about 5% of the total) is shown separately. It will be noted that production hit peak rate early in 1944 and has not quite held that rate despite unsatisfied demand. The reason is that plants were operated beyond their rated capacity and subsequently suffered from make-shift maintenance. There were also strikes in 1945 and 1946 as well as work stoppage due to lack of coal and transportation. The industry's basic capacity has not increased since early 1943 and then by only about 3% over the capacity in the middle '30's.

Production has been increased for natural soda ash because this could be done in a shorter period of time. All of this natural soda ash is produced in the West and to date the quantity has been sufficient only to supply West Coast demands. Therefore in most of this discussion we will confine ourselves to ammonia soda ash which supplies all requirements east of the Rocky Mountains.

Ammonia soda ash production is distributed as shown in Chart 2. In 1946 a little less than a third (31%) of the soda ash was made for "captive" use—that is, it was used by the producer to make other products. Much of this ash is consumed in crude form and the producers do not have capacity to make it into finished ash. The other two-thirds of production is divided about evenly between light and dense ash, with dense having a slight edge. It is the dense ash that is used for glass making and that industry takes over 80% of the entire output.

The industries to which soda ash is sold are shown in Chart 3. This chart shows the rapid increase in sales from 1940 to 1943 when peak capacity was reached. Also it is interesting to note that in 1946, the first postwar year, sales were 32% higher than in 1940. The glass industry did very well in obtaining its share of scarce soda ash in 1946 too, because the industry received 44.5% of the total sales that year compared to only 35.5% of the total in 1940.

This chart gave us our first clue to the probability of a postwar shortage. In 1944 we were blaming many of our difficulties on the substantial shipments being made to Uncle Sam's powder plants and aluminum plants. Though these shipments were large in tonnage, they were small in proportion to the whole and were nowhere near sufficient to cope with deferred consumer demand for bottles and other civilian goods. Furthermore, the big part of the aluminum demand was over long before the war was won. There were, of course, large war demands for soda ash which were indirect in nature and are included in the figures for regular consumer industries — such as glass for military purposes. Since the depression, the glass industry has represented the fastest growing market for soda ash. Chemicals have been a fairly close second, and all other industries are distinctly secondary in their effect on the soda ash trend. The gradual decline in soap and cleansers has been balanced by the gradual increase in pulp and paper. Non-ferrous metals (mostly aluminum) had a rapid rise and fall during the war period, reaching a sharp peak in 1943.

FIG.5

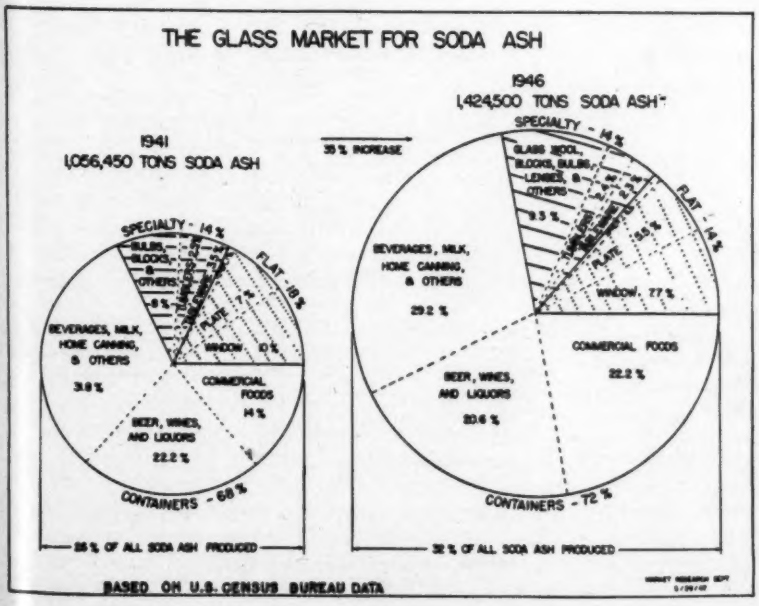
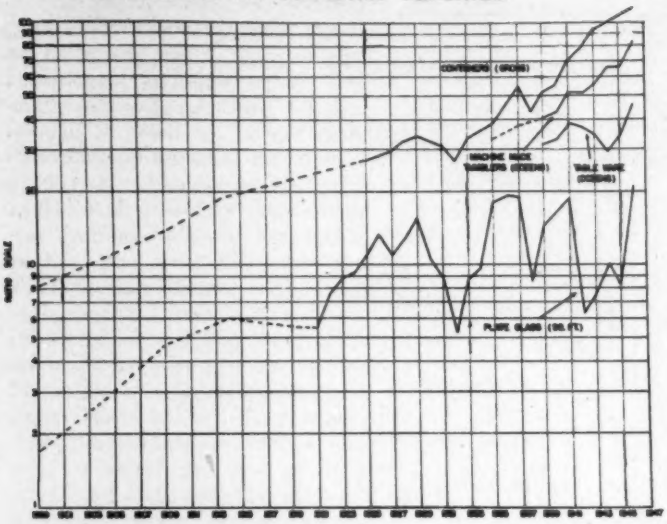


FIG. 6

GLASS PRODUCTION CURRENTLY REPORTED



SOURCE: U.S. DEPT OF COMMERCE

The Relation Between Soda Ash and Glass

As stated earlier, glass is the most important market for soda ash. It therefore merits careful study by soda ash producers. We have spent years of market research at Wyandotte on this subject and have much more detailed data than can be shown here in the time allotted. We can summarize our findings on four charts. The first is an overall analysis of the glass market as it was in 1941 and in 1946. During that 5-year period the use of soda ash increased 35% and still we could not supply enough. In 1941 the glass industry took 26% of all the soda ash produced and in 1946 the proportion had gone up to 32%. Container glass accounted for the bulk of the consumption both years—68% in 1941 and 72% in 1946. Specialty glass remained constant at 14% of the market and flat glass fell off from 18% to 14%. This, of course, was due to the fact that flat glass markets—mainly automobiles and housing—had not fully reconverted in 1946.

We were able to build up this statistical picture because of special wartime reports compiled by the government. Now, in order to keep this information current, we have had to rely on a different type of report, published currently, from which we could construct a soda ash consumption index by the use of weighted factors. The elements of our index are shown on the next chart. These figures represent about 80% of the industry tonnage-wise. We have made studies of the cyclical variations and seasonal trends in each of these industries.

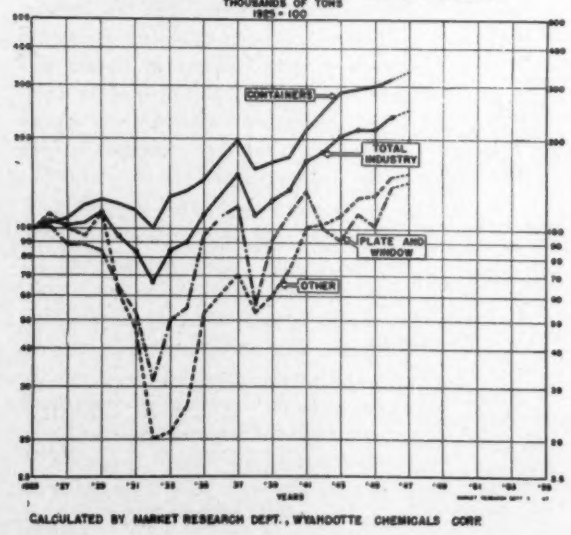
Translated into soda ash consumption, the figures look somewhat different. Using 1925 as a basis, container glass is now using more than three times as much soda ash whereas plate and window and other glass are using only 1.5 times as much. Also, in the intervening years, containers have shown steadier growth and less vulnerability to depression. This is accounted for by the strong tie-in between glass containers and food and also by the rebirth of beer and liquor business. The overall index is estimated at 250 for 1947.

We noted earlier that glass uses over 80% of all dense soda ash. Therefore, it is logical that there should be a close correlation between production of these two items. Apparently glass is subject to a greater monthly variation but the quarterly rates show a major difference only in 1946 when glass was able to weather through the coal strike in better shape than dense ash. Long term deviations are accounted for by changes in

(*Continued on page* 342)

FIG. 7

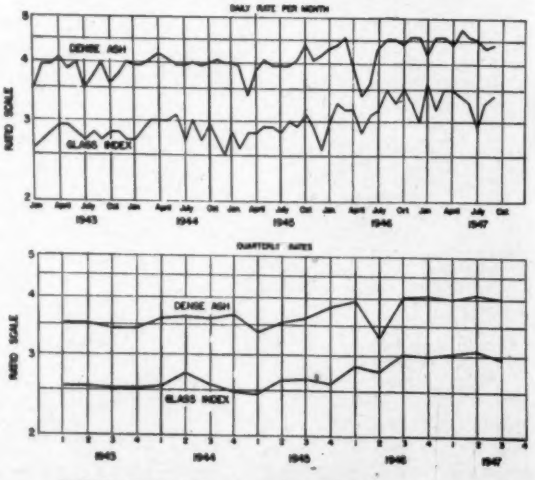
INDEX OF SODA ASH CONSUMED BY GLASS INDUSTRY



CALCULATED BY MARKET RESEARCH DEPT., WYANDOTTE CHEMICALS CORP.

FIG 8

RELATIONSHIP OF GLASS TO DENSE ASH



SOURCE: DENSE ASH – U.S. CENSUS BUREAU
GLASS INDEX – MARKET RESEARCH DEPT., WYANDOTTE CHEM. CORP.

GOVERNMENT CLOSES CASE IN FLAT GLASS ANTITRUST SUIT—COURT RECESSES UNTIL NOVEMBER

On grounds that the Antitrust Division of the Department of Justice had failed to show prima facie evidence of an overall conspiracy of flat glass manufacturers, in more than nine weeks of trial before Federal Judge Frank L. Kloeb, defendants filed motions on May 14 asking the court to dismiss the complaint.

Eight manufacturers of flat glass products, a trade association and 11 officers or representatives of the corporate defendants were named in the amended complaint on which the trial was based.

A separate motion was filed by George D. Welles, counsel for Fourco Glass Co., Rolland Glass Co., and W. M. B. Sine, an officer, not only asking dismissal, but alternatives asking an order dismissing the claim for dissolution of Fourco and the requirement that Rolland Glass sell all but one of its window glass factories; or an order requiring the Antitrust division to elect whether it will stand on allegations of the amended complaint that Rolland and American Window Glass were allegedly guaranteed quotas for window glass production or the statement in the bill of particulars that American Window Glass and Fourco were the window glass makers who got the quotas and joined the alleged conspiracy, or an order striking out hundreds of documents put into evidence which deal with plate glass, safety glass, tempered glass, bent glass, invisible glass, and foreign agreements in which Fourco and Rolland had no part.

All evidence relating to trade practices prior to Oct. 30, 1937 when the Federal Trade Commission entered a cease and desist order against most of the manufacturers of flat glass and some trade associations, was asked to be stricken out of the case on the grounds that there is no claim or evidence that the FTC order has not been obeyed, no claim or evidence that trade practices prior to the order were unlawful, and no evidence "tending to show any threat or danger of future failure on the part of the defendants herein to obey the FTC order."

Other defendants in their motions declared all testimony and exhibits should be stricken from the record on the grounds that "no showing of any conspiracy has been made."

In the alternative to the motion to dismiss, the defendants asked that the court order a dismissal of the claim for divestiture of factories sought against American Window Glass, Libbey-Owens-Ford and Pittsburgh Plate, and also the claim for divestiture of warehouses and stores against Pittsburgh Plate, on the ground "that upon the facts and the law plaintiff has shown no right to said relief or any part thereof."

This group of motions was signed by members of eight law firms and general counsel for defendant companies.

In the more than nine weeks of trial the government called only nine witnesses and presented testimony of two additional persons by deposition and stipulation. Nearly 2,000 documents, stipulations, answers to interrogatories, and charts were put into evidence indicating that the case may set a new record for extent of testimony in federal court in Toledo.

Three of the witnesses are government employees including Burnham W. Diggle housing expeditor; William Lawson, economic analyst of the Department of Commerce and former NRA assistant deputy administrator, and Haldor R. Mohat, statistician for the Antitrust Division. Nestor R. Scohy, Columbus; William J. Mathews, Yonkers, N. Y.; and William Frederick Cook, South Africa, by deposition, are former glass manufacturers. Paul A. Hughes, Pittsburgh, glass statistician; J. B. Ford, Detroit, great-grandson of first plate glassmaker in America, chemical manufacturer and supplier of soda ash to the glass industry; Irwin J. Kosson, Passaic, N. J., glazing contractor; Louis Bartelstone, Farmingdale, N. Y., operator of laminating plants, and Davis Kolb, Fort Smith, Ark., former plant superintendent for Harding Glass Company, testifying by stipulation, were other witnesses.

Irwin J. Kosson, of Kosson and Sons, Passaic, N. J., glazing contractor, was put on the stand Tuesday morning and testified that he had made repeated efforts beginning in 1930's to buy glass directly from the factory. He testified to meetings with various sales officials of Libbey-Owens-Ford Glass Company, Pittsburgh Plate Glass Company, American Window Glass Company, Fourco Glass Company and Franklin Glass Corporation and that he was told that his requirements could be met by jobbers in the New York metropolitan area.

He also declared he had tried twice unsuccessfully to join the National Glass Distributors' association. Letters introduced and sections of the NGDE constitution read into the record showed definite qualifications required for membership so as to preserve the jobber character of the association.

On cross-examination Mr. Kosson admitted his gross sales increased from $250,000 in 1939 to about $450,000 in 1945. He also admitted that on glazing contracts he figured his overhead and profit at about 35 per cent. He testified that he did glazing work on postoffices in Worcester, Woburn, Holyoke and Chicopee Falls, Mass., and other jobs scattered from Maine to West Virginia.

John T. Cahill, chief defense counsel, also elicited from the witness that he had at least five active competitors in Passaic and vicinity, and read a long list of glaziers, many of whom Mr. Kosson identified as active bidders at times.

He said about 50 to 75 per cent of his firm's total business was contract glazing. He also admitted that he had received two carloads of glass from Pittsburgh Plate on specific dates in 1936 and 1940.

Mr. Cahill to Witness: "Now, you don't advocate that your customers be sold direct by the factory, do you?"

Mr. Kosson: "No, I do not."

Walker Smith, plaintiff counsel: "I object to that, Your Honor. I don't think what Mr. Kosson advocates is material to this lawsuit."

The Court: "He answered the question."

Considerable argument was generated when attempts were made to ask Mr. Kosson some questions about his business in 1947, plaintiff counsel objected, and Mr. Cahill said the defense should not be bound by any self-imposed restriction adopted by the plaintiff to limit all testimony up to date of filing of the complaint, main-

taining that in equity "the decree speaks of the events as they stand at the time of the entry of the decree . . . the defendants have the right as a matter of law to go into events subsequent to the filing of the bill."

Ross Shumaker, counsel for Pittsburgh Plate, pointed out how Antitrust division counsel had gone into events up to 1947 only a few minutes before, and George D. Welles, counsel for Fourco, argued that the court would have to determine, in considering any relief, "the present threat" of wrong-doing on part of defendants. The court indicated opening up the line of questioning, however, might postpone the hearing six months or a year and there would be no end. He sustained an objection to a question relating to 1947.

In the field of alleged retail price maintenance the plaintiff introduced a series of letters dealing largely with complaints of jobbers in various areas about so-called price-cutting tactics of competitors.

One letter from American Window Glass Company to Broudy Glass Company, Boston, on Aug. 31, 1937 acknowledging an order for a carload of glass declared the sales policy was "clearly and definitely outlined."

"We have no desire to dictate to you or any dealer the price at which he should resell his glass," declared the letter. "However, if any dealer resorts to price cutting, or unethical practices in any particular territory, resulting in, as it inevitably does, other dealers meeting that competition, sooner or later the orderly conduct of business in that territory is disrupted, and the manufacturer is called upon to place other dealers in a position to compete. A condition of this kind cannot be confined to a particular territory but eventually spreads throughout the country and would, if permitted, destroy the manufacturer's market."

Hearings were resumed with John B. Ford, Jr., executive vice president of the Wyandotte Chemicals Corp., Wyandotte, Mich., called to the stand by the plaintiff.

Mr. Ford is a grandson of the late Edward Ford and son of John B. Ford, formerly president of the Wyandotte Company.

He was asked by Curtis Shears, chief of the Antitrust division counsel, to identify several documents relating to a series of loans aggregating $500,000 made to Fourco Glass Company about Oct. 15, 1935.

Board minutes of the Michigan Alkali Company, Wyandotte, predecessor of Wyandotte Chemicals Corporation, showed the loan was to carry four per cent interest, and to be repaid in monthly payments at a rate of 10 cents a box on glass sold by Fourco Glass Company.

Mr. Ford said the chief consideration and security for the loan was a soda ash contract to supply the Fourco plants for five years. He said "We had lots of money and were operating at about 60 per cent of capacity. We felt the loan was a good investment, as it proved to be."

Later on cross-examination Mr. Ford said the company had in its treasury at that time about $15,000,000. He said Michigan Alkali gained new customers and booked about $1,000,000 of soda ash sales through the contract. Defense counsel introduced several letters to show that Michigan Alkali agreed with Fourco on a waiver of payments during adverse business conditions in 1938.

Interrupting its presentation of several facets of international trade in glass at the end of the eighth week of the trial the Antitrust Division brought in Louis Bartelstone, Farmingdale, N. Y., head of the Multi-Plate Glass Corporation since 1940, and formerly associated with the Indestructo Glass Company from 1917 up to its failure in 1933 or 1934, as a witness covering some phases of safety glass business.

On direct examination by Kenneth R. Lindsay, plaintiff counsel, Mr. Bartelstone described his Indestructo organization in 1928 as having a 50,000 square foot plant on a 17-acre site on Long Island, employing about 220 persons, and having $500,000 in the bank.

He said he had contracts with Packard, General Motors, GM Trucks, Lincoln, American Rolls-Royce, American Car & Foundry and some bus companies to furnish safety glass.

Bartelstone described discussions with Libbey-Owens Sheet Glass technical men regarding patents and some attempts to buy thin plate glass from the company. He said J. C. Blair, then president of Libbey-Owens, had told him that the company needed all it made for its own purposes. The witness said he bought large quantities of glass from Europe and some indirectly from American makers through jobbers, the latter costing him 20 to 25 per cent more than direct factory purchases.

From 1940 to 1945 he acquired some glass through Corona Glass Company, a jobber unit which owned a half interest in his Multi-Plate operation. He said this was Pittsburgh Plate glass. Some additional glass from jobbers he declared bore LOF labels. His purchases in 1945 of sheet glass at 79 off list he said was about 17 per cent above the factory price to jobbers.

John T. Cahill, chief defense counsel, conducted the cross examination during which Mr. Bartelstone refused to admit that he got any glass direct from Libbey-Owens-Ford or Pittsburg Plate and when confronted with numerous invoices he said he had no recollection of such direct factory purchases at the direct factory prices.

Confronted with book records of payments for glass he had no recollection of the payments in 1930 which appeared to be slower and slower with none discounted. He maintained his company was a prompt payer but said it may have gone slow towards the end.

He could not recall the liability against the $500,000 in Bank of Manhattan he had testified as belonging to Indestructo in 1928. He could not recollect giving any notes.

He admitted that Multi-Plate was set up with $7,500 of capital furnished by partners and he put in "brains". The witness contended the company is now worth $35,000 and it is owned by himself and son-in-law. Purchases of glass are made through associates, he said. He said all judgments against him had been cleared and could not remember several cited by defense counsel.

Mr. Cahill not only attacked his credit record and history of poor payments, his factory shipments of glass, but also confronted the witness with tests data which showed that Indestructo glass did not always measure up in quality to state standards. The witness could recollect very little about such matters.

He also declared he had no recollection of shipments of more than 500,000 square feet of glass in 1928 to 1930 from Pittsburgh Plate factories and large amounts from Libbey-Owens-Ford covered by 15 invoices which Mr. Cahill offered to submit to the court.

Mr. Bartelstone in his testimony charged directly that the company lost out because it could not buy glass directly from the factory.

"Didn't there come a time, early in 1931, when Libbey-Owens-Ford said it would not sell to Indestructo, except with a bill of lading, sight draft attached, because you were so far behind in your 1930 payments?" asked Mr. Cahill.

"It could be," Mr. Bartelstone admitted.

In between his ventures in laminated glass, Mr. Bartelstone testified that he promoted the Barco Manufacturing Company, to manufacture and sell through retail stores, a chemical household cleaning compound. Eventually the business was turned over to a son-in-law and sold to others.

The defense asked the opportunity to recall the witness, if necessary for further cross-examination on the grounds that the government had not notified the defense until late April 28 that the witness had been subpoenaed.

A brief written argument was laid before the court to strike out the Ford Motor documents which have been in, out and again in the case.

"There is not, and there has never been, any agreement restricting Ford's manufacture of plate glass," declared Pittsburgh Plate Counsel. "The 1927 agreement is non-restrictive, and the Government so conceded. That agreement is still in effect. The 1937 agreement is a window glass agreement. Therefore, Exhibit 619 (dealing with plate glass), cannot connect Pittsburgh Plate to the Ford-LOF unrestrictive 1927 agreement, to unsuccessful Ford-LOF negotiations in 1932-33, or to the Ford-LOF window glass agreement of 1937."

William T. Jeter, government counsel, told the court the NRA codes were designed to carry forward freight equalization, price fixing, production quotas, credit terms, pool car bans, and qualified buyers' lists. The court said he thought the plaintiff was "treading on dangerous ground."

On cross examination Mr. Lawson admitted that the late Eugene Rolland had fought for a price differential for the smaller window glass plants and such an idea had been just as vigorously opposed by Libbey-Owens-Ford and Pittsburgh Plate Glass.

He also admitted that there was great excess productive capacity in the window glass industry in the early 1930's.

It was also shown by his testimony and letters introduced that Pittsburgh Plate Glass definitely opposed proration of production as unfair to the efficient producers.

Mr. Welles read into the record the statement of the NRA that there were 17 known manufacturing plants making window glass at the time of the "blue eagle". Several were in financial difficulties, mortality rate was high, there was 300 per cent more capacity than required, a general feeling of panic in the industry and lowering of prices. Mr. Lawson admitted that was a picture of the industry at that time.

Charts purporting to summarize evidence as to prices of plate and window glass, percentage of industry production of window glass by companies, relation of factory-buying jobbers to volume of shipments, and historical development of plate glass manufacturing in the period 1928 to 1945 were introduced by the Antitrust division in its closing move in the hearing of the antitrust suit before Federal Judge Frank L. Kloeb.

Haldor R. Mohat, Washington, statistician for the Antitrust Division, was put on the stand and identified and explained the charts.

Although he testified that he took full responsibility for the making of the charts on cross-examination by John T. Cahill, chief defense counsel, Mr. Mohat admitted most of the selection of the material and the method of preparing the charts was suggested by and passed on by Curtis Shears, special assistant to the attorney general, in charge of the presentation of the case.

Rearrangement of two of the charts by the defense and an overlay to show general business trends were refused by the court as defense material rather than cross-examination.

In the final court session George D. Welles, counsel for Fourco and Paul Winschel, counsel for American Window Glass, attacked the window glass data in the charts by way of cross-examination, and Leland Hazard, vice president and general counsel for Pittsburgh Plate, went into the plate glass data.

Mr. Shears admitted that several errors had been brought up and offered to amend the charts before laying them before the court.

Ross Shumaker, counsel for Pittsburgh Plate, however, objected to all the charts and moved that they be stricken from the testimony. He said the charts and the evidence offered by Mohat were not evidence at all but solely an argument and an attempt to explain and interpret evidence already in the record, that the charts were incomplete, inaccurate and misleading, that they did not fairly represent evidence but merely gave a partisan and distorted view of evidence, they did not provide any demonstrative evidence such as maps, diagrams, and pictures sometimes do, and they did not fall within the rule whereby experts may make summaries or abstracts of testimony to aid the court.

He declared the witness had offered no opinion nor any new evidence.

The court overruled the objection, however, on the grounds that there are some features of the charts which may help. He ruled that legends on the charts would be limited to mere reference and not taken as factual proof.

Judge Kloeb complimented counsel for both plaintiff and defense as having done an excellent job in presenting the evidence so far.

He said it was not out of place for the court to suggest that as sensible men who have gone minutely into the details of the case they might try to come to some agreement.

"I rather think it would do no harm for counsel to discuss their relative positions at some time in the next two or three weeks. I do not think either one of you are in any condition to knock at the pearly gates and demand admittance without a thorough cleansing and an examination of your consciences. I think that is in order. Knowing that to be the fact, it seems to me that rather than putting the burden on the court and continuing a trial here for another year, that you might get your heads together and settle your differences, settle them just as well as the court could. I merely drop that as an additional suggestion at the close of the plaintiff's case."

The court quizzed counsel on the date for presentation of the defense and it was indicated that it would probably be about November 1.

BORIC OXIDE—ITS CHEMISTRY AND ROLE IN GLASS TECHNOLOGY

By W. A. WEYL
The Pennsylvania State College, State College, Pa.

PART IV

2. *Electrical Conductivity.* The electrical properties of glasses have been investigated from two different points of view. From a technical standpoint glasses form an important group of electrical insulators. It is desirable to learn how their electrical properties can be improved by adjusting their compositions. Boric oxide ranks first among those constituents which help to produce a glass of low power loss and optimum electrical insulating power within the technically meltable composition range. The role of boric oxide in this respect is rather complex; much of it can be explained on the basis that alkali is the chief offender decreasing the insulating power of a glass, partly by producing conducting surface films. Alkali is also chiefly responsible for the power loss of a glass. Boric oxide makes it possible to produce easily meltable glasses of low alkali content and good working properties. For giving a more detailed picture, our knowledge of the electrical properties of glasses is too meager. Systematic work on the electrical properties of glasses as a function of their composition from a technical viewpoint began in the Osram Laboratories, Berlin, Germany in 1925. The work of Gehlhoff, Thomas and Fulda forms the basis for the understanding of electrical properties of technical glasses as affected by changes in composition.

The effect which temperature exerts upon the electrical conductivity was found to be relatively simple. Several workers in this field confirmed that the increase in electrical volume conductivity of a glass with increasing temperature follows closely a function which was derived for electrolytes by E. Rasch and F. W. Hinrichsen (1908).

$$\log R = A/T + B$$

If the logarithm of the specific resistivity R is plotted as a function of the absolute temperature T, the curve is a straight line between room temperature and approximately 450° C.

No such simple relation could be found for the conductivity of a glass and its composition. Gehlhoff and Thomas, who wanted to express the influence of the various glass constituents on the electrical properties in the form of "factors" had to modify their usage and give the factors for different small composition ranges.

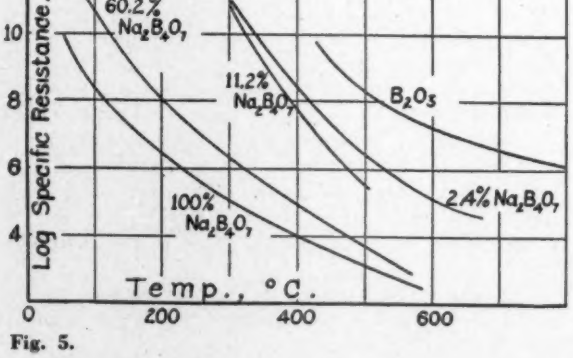


Fig. 5.

Much more systematic work is needed for a better understanding of the electrical properties of glass in relation to other properties and its composition. Our present knowledge can be briefly summarized as follows:

a) The use of glass as an electrical insulator is chiefly determined by its chemical resistivity. At room temperature the volume conductivity, even of poor glass, is so high that the glass can be considered a perfect insulator. However, the surface film which forms on glasses exposed to the atmosphere impairs their electrical insulating power. Methods have been devised to keep alkali ions in the surface to a minimum. (Coating with organic silicones, dealkalization of the glass surface.)

b) Electrical conductivity of a glass is due to the presence of alkali ions. The mobility of these ions is so much greater than that of other glass constituents that the contributions of the latter can be neglected for all practical purposes.

c) The volume conductivity of a glass can be strongly influenced by the composition. The number of alkali ions per unit volume is of secondary importance. The chief factor determining the electrical conductivity is the mobility of these ions and as a result, boric oxide which decreases their mobility improves the electrical properties of a glass. Other oxides which exert a similar effect are BaO and PbO.

d) Electrical power loss of a glass is greatly affected by alkali. Whereas in the electrical conductivity the alkali ions migrate through the volume of the glass, the power loss is the result of the vibration of these loosely bound ions oscillating around their equilibrium positions and transforming electric energy into heat. For improving the power factor of a glass similar rules hold true as for improving its insulating power. Low alkali, addition of B_2O_3, PbO and BaO as well as use of mixed alkalies instead of one.

From a scientific viewpoint the electrical properties of borate glasses contributed much to a better understanding of the problem of the constitution of glasses. The accuracy of electrical measurements combined with the relatively low temperatures required for measuring borates makes this field an ideal basis for structural research.

M. Foex in France (1939) used the electrical conductivity of borates as a tool for examining immiscibility phenomena. Boric oxide upon addition of many divalent oxides separates into two liquid phases, one of which having a high boric oxide content forms a glass on cooling. This melt has a low electrical conductivity. The other liquid phase having a low B_2O_3 content crys-

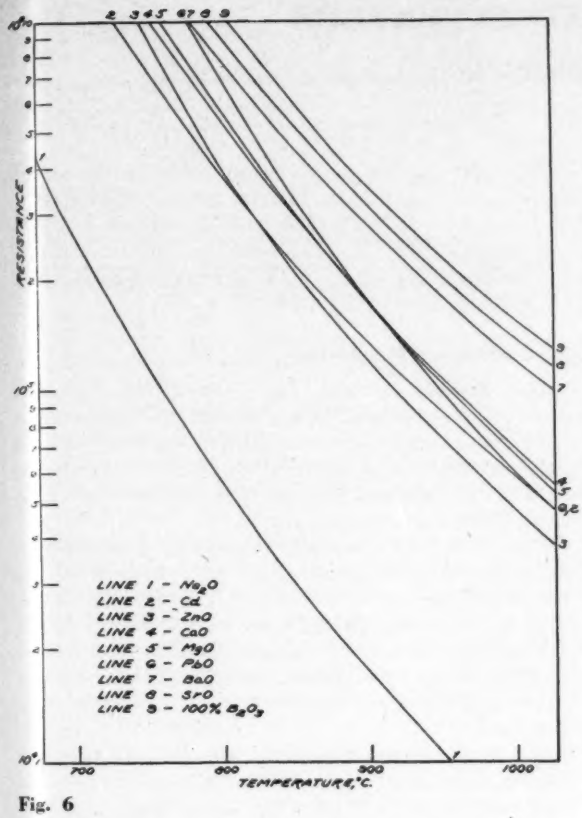


Fig. 6

tallizes on cooling. This phase has a high electrical conductivity.

The alkali borates were examined by several Russian scientists, Mueller, Schushukarew and Markin. Their work reveals important information on the mobility of the different alkali ions. As one would expect their mobility decreases with their ionic size. Li^+ being the most mobile, then the other ions follow in the order Na^+, K^+ and Rb^+. Surprising, however, is the influence which the composition of the glass exerts upon their mobility. Alkali borates containing BaO have a much lower electric conductivity than one would expect from their alkali content. Furthermore, the equivalent replacement of one alkali by another causes the electrical conductivity to go through a deep minimum.

Optimum insulating properties of mixed K_2O-Na_2O properties were also reported by Gehlhoff and Thomas.

Of particular theoretical interest is their work on silver ion containing glasses. In the past the role which ionic size and charge play in determining the behavior of a glass constituent have been over-emphasized in scientific publications. Only recently the importance of the electronic structure of the ions has been recognized and applied to structural considerations. Ag^+ and Na^+ have identical charge and about the same size. Their outer electronic structures, however, are different. The Na^+ has eight outer electrons, a very stable configuration, the same which is responsible for the inertness of the rare or noble gas atoms. The Ag^+ has 18 outer electrons. Mueller and Markin found that among all ions examined the silver ions have the highest mobility in borate glasses.

S. B. Thomas (1931) measured the specific resistance of some B_2O_3 — $Na_2B_4O_7$ glasses. The results are plotted in Fig. 5.

William W. Colbert (Thesis, The Pennsylvania State College, State College, Pa.) studied the participation of divalent ions in the electrical conductivity of borate glasses. The low solubility of divalent oxides in pure B_2O_3 makes the exact determination of their contribution difficult. His work brought out that there is no simple relation between mobility of an ion and size. Mg^{2+} and Ca^{2+}, also the much larger Ba^{2+}, have a higher mobility than Sr^{2+}. It seems that the mobility of an ion in an electric field is governed by two opposing influences. With increasing size of an ion, that is $Li^+ < Na^+ < K^+$, the transport becomes more difficult. On the other hand, the bond strength decreases and with it the energy barrier of the process (activation energy). Mg^{2+} and Ca^{2+} are smaller than Sr^{2+} and consequently, have a higher mobility. For Ba^{2+}, however, the polarizability and deformability seems to overcome the size effect. This influence becomes even more evident if one compares ions of identical charge and similar size, such as Zn^{2+} with Mg^{2+}, Cd^{2+} with Ca^{2+} and Pb^{2+} with Sr^{2+}. In all these cases the heavy metal ions, Zn^{2+}, Cd^{2+}, Pb^{2+} produce a much higher conductivity than the corresponding rare gas-like ions Mg^{2+}, Ca^{2+} and Sr^{2+}. This is in accordance with the influence exerted by Ag^+ as compared with Na^+.

Fig. 6 gives the electrical resistance of pure vitreous boric oxide and with the addition of 0.1 mol% of the divalent cations Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Zn^{2+}, Cd^{2+} and Pb^{2+} according to the measurements of W. W. Colbert (1946). This figure includes the much lower resistance values of a sodium borate glass containing an equivalent concentration of sodium ions. No effort was made in this work to determine the specific resistivities of these glasses. The curves give comparative values only. The difficulties in determining the absolute electrical conductivities are due to the sensitivity of this property to impurities.

Previous workers, for example, K. Arndt and A. Gessler reported relatively high conductivities of pure B_2O_2 which are probably due to contaminations by the crucible material or by water content. Hydrogen ions are probably responsible for a good part of the conductivity of many glasses. G. P. K. Chu and W. A. Weyl were able to lower the electrical conductivity of a sodium borate glass to nearly one-half of its original value by thoroughly removing the water either by electrolysis or by addition of substances, such as magnesium silicide, which chemically remove the water from the melt.

Higher mobilities of non-noble-gas-like ions as compared with noble-gas-like ions have been found for crystallized substances. Such is the case for the alkali halides as compared with the silver or cuprous halides. For the development of glasses with special electrical properties it is important to realize that the loosely bound ions are responsible for the conductivity. Transfer of electric charge is intimately connected with transfer of matter. The flow of ions, such as Na^+ or Ag^+ through the glass consists of a jumping from one position to another and is not comparable with a steady flow to which the laws of hydrodynamics may be applied. Not their "friction" are the determining factors but the

(*Continued on page* 346)

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Glass Compositions

Corning Fluorescent Glass. Patent No. 2,440,048. Harrison P. Hood assigned this invention to Corning Glass Works. Due to the fact that this batch can be easily and accurately controlled, a greatly improved glass results.

The following batches in parts by weight are examples of compositions containing copper oxide and ammonium chloride in accordance with this invention:

	A	B	C
Sand	100	100	100
Na_2CO_3	12	42	22
K_2CO_3	38	...	10
$Al(OH)_3$	2	3.2	15
$Ca\ CO_3$	12.5	21	...
Cu_2Cl_2	1.1	...	...
NH_4Cl	0.8	2.4	1.8
CuO	...	0.15	0.15
SnO_2	...	0.35	0.35
CeO_2	...	0.05	0.05
$BaCO_3$	...	...	16
Na_2SiF_6	...	...	5

The above batches, when melted, will produce the following glasses as calculated in per cent by weight.

	A	B	C
	Per cent	*Per cent*	*Per cent*
SiO_2	72.4	72.0	70.5
$Na_2O + K_2O$	21.0	17.6	13.5
Al_2O_3	1.0	1.5	7.0
CaO	5.0	8.5	...
BaO	...	...	8.6
Cu_2O	.6	.1	.1
SnO	...	.2	.2
Ce_2O_3	...	.04	.04

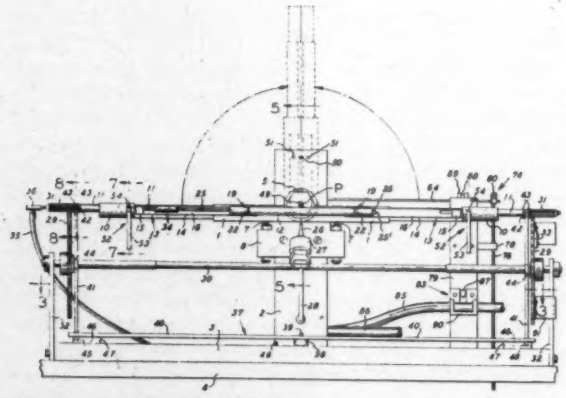


Fig. 1. Tube Bending Machine.

The following references are of record in the file of this patent: United States Patents: 288,056, Higley, Nov. 6, 1883; 1,482,389, d'Adrian, Feb. 5, 1924; and 2,099,602, Fischer, Nov. 16, 1937. Foreign Patents: 752,636, France, Sept. 27, 1933. Other References: *Glass Industry*, September 1935, page 273.

Miscellaneous Processes

Tube Bending Machine. Fig. 1. Patent No. 2,439,902. This invention is particularly useful in bending glass tubes into U-shape for use in electric discharge devices such as germicidal lamps. It was invented by Edward B. Noel of Cleveland Heights, Ohio, who assigned it to General Electric Company.

The bending of tubes into U-shape by hand requires great skill if a uniform product is to be had. When the U-tube is to be used in devices such as germicidal lamps, it is important that the thickness of the wall on the inside and outside of the bend shall be as nearly as possible the same. This invention makes bends of this character much better and cheaper than has heretofore been possible.

Fig. 1 shows a front elevation of a machine having a pair of swivel arms 1, mounted on a bracket 2, carried by a bed plate 3. These arms are mounted to swing about a stud 5 and normally extend horizontally into a position determined by stop screws 7. The outer ends of the arms 1 carry bearings 10 for hollow shafts 11 which are offset below the pivot point P by a distance at least equal to the outside radius of the curve to be made in the glass tube 12. The inner ends of the shafts 11 have a pair of holders 13 which grasp the tube to be bent. Spring clips 19 hold the glass tube in V-grooves.

Exhaust tubes 25 are connected to both ends of the tube to be bent, one of these being tipped off as shown at 25'. After the tube has been placed in position, the place where the bend is to be made is softened by a gas fire 26 from a burner 27 during which time the tube is rotated or oscillated by gears 29 mounted on a shaft 30 turned by a hand lever 33. To prevent the tube from collapsing, low pressure air is supplied through a tube 35.

After the tube has become soft where the bend is to be made, the ends of the tube are moved toward one another to upset and thicken the glass where the bend is to be made. This movement is produced by a hand lever 38 connected by links 40 to yokes 42 which act upon opposite ends of the tube. A stop pin 48 is provided to limit this movement. When the glass at the bending point has been sufficiently thickened, a forming pin 49 is moved into position above the point where the bend is to be made and the arms are swung upwardly through 90° into the position shown in dotted lines where they are positioned by a stop pin 50. The arms are held here by snap pins 51. This produces a close U-bend with the glass at the bend of uniform thickness.

This patent shows no references cited by the Patent Office.

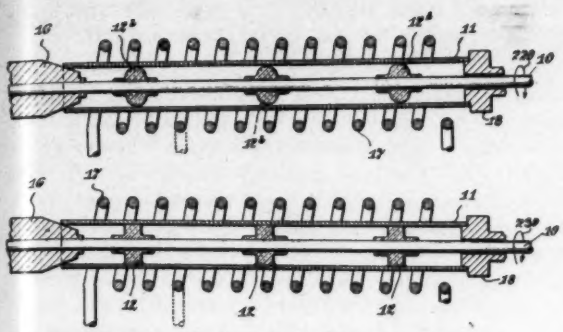


Fig. 2. Method of Sealing Coaxial Structures.

Method of Sealing Coaxial Structures. Fig. 2. Patent No. 2,439,916. This is the invention of Leo C. Werner and Willard S. Lund of Bloomfield, N. J., who assigned it to Westinghouse Electric Corporation. Heretofore it has been possible to place only one insulating bead around a rod coaxially positioned within a tube because the bead had to be pressed from both sides to bring it into contact with the wall of the tube. According to this invention, any number of insulating beads can be positioned within the tube. This is made possible by the method of expanding the beads into contact with the tube by centrifugal force while the glass bead is heated to a fluent condition.

The upper part of Fig. 2 shows a rod 10 within a tube 11 and having three glass beads 12b secured thereon. These beads are formed by winding hot glass from a rod around a piece of glass tube placed over the rod at the desired places. The diameter of the bead thus formed is smaller than the bore of the tube so that the beads will enter the tube. Both the rod and the tube are held for rotation by a chuck 16 and a tail stock spindle 18. A high frequency coil 17 surrounds the assembly and power is applied while the tube and rod are rotated at low speed as indicated by the arrow 220. This softens the glass of the beads and when they are sufficiently hot, the rotation of the parts is speeded up to about 2,000 R.P.M. The centrifugal action causes the beads to flow into wetting engagement with the tube and a series of seals 12 are formed as shown in the lower part of the figure. This method avoids any axial pressing of the several seals.

The following references are of record in the file of this patent: United States Patents: 1,271,245, Recklinghausen, July 2, 1918; 1,639,575, Robinson, Aug. 16, 1927; 1,844,936, Hotchkiss, Feb. 16, 1932; 2,048,556, McArthur, July 21, 1936; 2,138,224, Barasch, Nov. 29, 1938; 2,202,337, Cohn, May 28, 1940; 2,276,218, Lemmens, Mar. 10, 1942; and 2,394,398, Mouromtseff et al., Feb. 5, 1946. Foreign Patents: 198,322, Great Britain, July 26, 1923, and 455,101, Great Britain, Oct. 14, 1936.

Forming Films on Glass. Fig. 3. Patent No. 2,439,-999. This patent was assigned to Pittsburgh Plate Glass Company by Frederick W. Adams of New York City. The object of the invention is to provide a very thin uniform film on a glass surface to protect it from chemical action and to reduce reflection without changing the optical quality or appearance of the glass. This is particularly important in double-glazed windows where the inner surfaces can not well be cleaned and on which a scum is likely to form in the course of time.

Heretofore it has been proposed to treat the glass surface by etching it slightly thereby leaving a thin film rich in silica but this was not completely satisfactory. In accordance with this invention, a thin film of almost pure silica which can be hardened by a mild baking operation provides the desired protection and reduces reflection without any of the objectionable features previously encountered.

The film is formed on the glass body which may be in the form of window glass, lenses, mirrors or almost anything else, by first placing it in an autoclave where it is subjected to the action of a hot aqueous solution of common salt or other sodium salt. The temperature should be about 200°C., and the pressure 200 to 300 pounds per square inch depending somewhat on the composition of the glass being treated. A film of a thickness of 3 to 6 millionths of an inch can be formed in 5 to 20 minutes. The glass is then washed and baked at a temperature of about 200°C., for 10 or 15 minutes. If desired, a film having a thickness of ¼ of the wave length of D sodium light may be produced.

Several modifications of the process are suggested, one of these involving the method disclosed in Patent No. 2,348,704 issued to the same inventor.

Fig. 3 shows an apparatus for practicing this method. An autoclave 10 comprises a receptacle 11 having a cover 18 and a grid 19 carrying points 19a to support a glass plate 20. The etching fluid is in a container 21 heated by a coil 22 and it is delivered to the autoclave by a pump 24. Suitable pipe lines are provided so that the fluid may be returned to the container 21 at the end of the treatment. The washing fluid is in a container 29 and is delivered by a pump 32. The necessary valves are provided for supplying and withdrawing the fluids. Drying and baking the plate is effected by hot air from a heater 37 assisted by a fan 44. Electrical heaters 49 also help this operation. A heater 56 is used to raise the temperature of the etching fluid. The operation of this apparatus is apparent from the drawing.

The following references are of record in the file of

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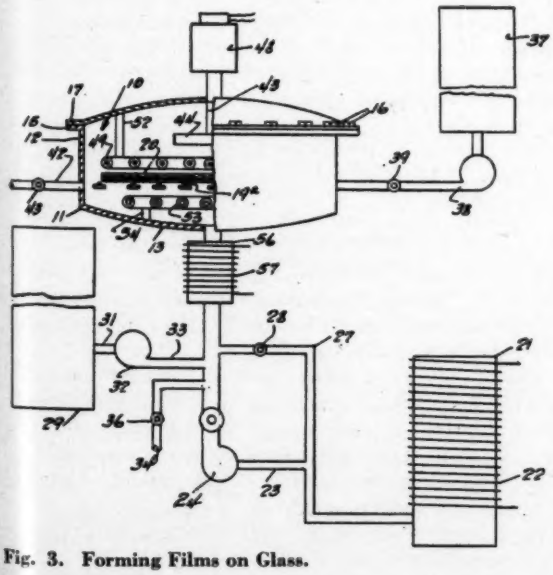
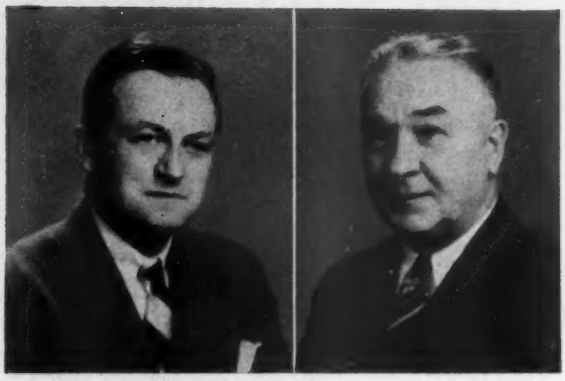


Fig. 3. Forming Films on Glass.



R. W. Knauft E. L. Bohn

CHAS. TAYLOR SONS MAKES PROMOTIONS

The Chas. Taylor Sons Company has recently announced the election of Robert W. Knauft as Vice President in charge of Sales and Edward L. Bohn as Vice President in charge of Production.

Mr. Knauft has been associated with the firm since 1930, working as a Field Representative and as General Sales Manager since 1942.

Mr. Bohn joined The Chas. Taylor Sons Company in 1937 following a long association with the Dover Fire Brick Company and North American Refractories Company. He served as Manager of the Fire Clay Products Division of Chas. Taylor until 1946 and will now devote his full time to Works Engineering and Production at both Cincinnati and Taylor, Kentucky factories.

DR. BADGER ELECTED FELLOW OF BRITISH SOCIETY

Dr. Alfred E. Badger, of the research staff of Libbey-Owens-Ford Glass Company, has been elected a Fellow of the British Society of Glass Technology, according to a recent announcement.

The honorary election is on the basis of contribution to the literature of glass technology. Dr. Badger has published more than 60 papers on the theory and practice of glass technology and in silicate chemistry. His works have dealt with fundamental properties of glass, heat in glass tanks, X-ray studies, formation of minerals and a broad field of effect of chemical composition on physical properties. Most of his recent work in Libbey-Owens-Ford has been on improvement of glass quality from the chemical approach.

REFRACTORIES INSTITUTE TO ISSUE DIRECTORY

The American Refractories Institute is preparing to revise the present issue of the Directory of the Refractories Industry, which was published in 1942. The Directory contains information as to the names and addresses of manufacturers of refractories, location of plants and an alphabetical listing of refractory products by brand names.

Any refractories manufacturers wishing to be represented in the revised Directory should contact the American Refractories Institute, Railway Exchange Building, St. Louis, Missouri.

WORKERS' UNION AND MANAGEMENT CONTRIBUTE TO PUBLIC RELATIONS CAMPAIGN

Glass Crafts of the U.S.A., an association of manufacturers of handmade glass in the United States, has announced the appointment of Catherine Blondin Associates, New York, as public relations counsel. The newly formed group will sponsor an educational campaign to familiarize the public with the domestic handmade glass industry of the United States. It is hoped that eventually this activity will be extended to include illuminating, scientific, laboratory and industrial handmade glassware.

Recognizing the fact that it would be practically impossible for American manufacturers of handmade glassware to successfully compete with foreign competition in this market as a result of low tariffs and a wage scale for foreign workers only about one-quarter that of American workers, the American Flint Glass Workers Union has joined with management in contributing to the educational campaign to be directed to the American public.

The Executive Committee of Glass Crafts of the U.S.A. is as follows: Chairman, W. L. Dalzell, President, Fostoria Glass Company; Vice Chairman, W. G. Muhleman, Vice President, American Flint Glass Workers Union; and Treasurer, Carl W. Gustkey, President, Imperial Glass Corporation. Other members of the Committee are C. W. Carlson, President, U. S. Glass Company; Frank F. Hyre, President, Dunbar Glass Corporation; C. T. Swartling, President, Viking Glass Company; and John C. Weber, Jr., Sales Manager, West Virginia Glass Specialty Company. H. L. Dillingham, Business Manager of the American Glassware Association, has been named Secretary.

DU PONT EXPANDS RESEARCH FACILITIES

A $30,000,000 expansion of research facilities at E. I. du Pont de Nemours & Company's Experimental Station in Wilmington has been approved by the Executive and Finance Committees and submitted for ratification to the Board of Directors.

Construction plans call for ten new laboratory and semi-works buildings for long-range research and development of new chemical discoveries. When the expansion is completed, the company expects to have 900 technical employees engaged exclusively in research work at the station, of which about 200 will be transferred from other laboratory locations. The total of all employees, technical and non-technical, will approximate 2,500.

AMERICAN OPTICAL SUPERINTENDENT DIES

James M. Canning, Superintendent in Department A11S of the American Optical Company, died suddenly, death being due to a cerebral hemmorhage.

Mr. Canning joined the American Optical Company in 1917 as assistant foreman in glass molding. He rose steadily in his job and was one of the organizers of the W.A.A., serving on several committees, including the Executive Committee. In 1922 he was elected President of the organization.

He is survived by his wife, Mrs. Mary L. (Fish) Canning, two sons and four grandchildren.

Research Digest

Properties of Soda-Strontium-Oxide-Alumina-Silica Glasses

For the past several years, the General Research Laboratory of the Owens-Illinois Glass Company has been publishing the results of composition-property studies on systematic series of soda-lime glasses. Their latest paper (*Journal of the American Ceramic Society*, January 1948) concerns strontium oxide instead of lime. In this study, data are presented on the properties of twenty-seven $Na_2O \cdot SrO \cdot Al_2O_3 \cdot SiO_2$ glasses covering the following percentage composition ranges: SiO_2 66 to 78; SrO 4 to 16; Al_2O_3 0, 2 and 4; and Na_2O 14, 15.5 and 17.

Strontium oxide was systematically substituted for SiO_2, Al_2O_3, and Na_2O and the effect on the liquidus temperature, viscosity, coefficient of expansion, deformation temperature, density and resistance to dilute acid and distilled water determined. (The method of preparing the glasses and the methods used for measuring the various physical properties were the same as has been previously described in these reports.)

From the data obtained, the following conclusions were reached (a comparison is also given between these SrO glasses and the corresponding CaO glasses):

1) Liquidus Temperature: a) The liquidus temperatures of SrO glasses are generally higher than those of corresponding CaO glasses. b) The substitution of SrO for SiO_2 causes reductions in the liquidus temperatures of the SrO glasses. The substitution of CaO for SiO_2 causes a steady increase in the liquidus temperatures of 17% Na_2O glasses, while causing, first, decreases and then increases in the 15.5 and 14% Na_2O glasses. c) The substitution of Na_2O for SiO_2 results in marked decreases of liquidus temperatures. The effect of this substitution in CaO glasses is quite similar. d) The substitution of Al_2O_3 for SrO results in sharp reductions of liquidus temperatures. The substitution of Al_2O_3 for CaO is generally the same; the reductions, however, are not so great. e) Cristobalite, tridymite, and strontium silicate are found as primary phases in the SrO glasses. The three phases found in corresponding CaO glasses are tridymite, devitrite, and wollastonite.

2) Viscosity: The substitution of SrO for SiO_2 results in marked reductions of temperatures at which "log viscosity = 3." This substitution causes small but definite reductions in the temperature at which log viscosity = 7.65. b) The substitution of Na_2O for SiO_2 results in marked decreases in "log viscosity = 3" temperatures; the corresponding reduction at "log viscosity = 7.65" temperatures is regular but less pronounced. c) The substitution of Al_2O_3 for SiO_2 results in small but definite increases in viscosity throughout the complete viscosity range.

3) Coefficient of Expansion (70° to 160°C): a) The substitution of SrO for SiO_2 causes substantial increases in the expansion coefficient. The increases caused by the substitution of CaO for SiO_2 are smaller. b) The substitution of Na_2O for SiO_2 causes large increases in the expansion coefficient of the SrO glasses. This substitution in the corresponding CaO glasses results in even greater increases. c) The substitution of Al_2O_3 for SiO_2 is without effect on the expansion coefficient. The effect of this substitution is the same for corresponding CaO glasses.

4) Deformation Point: a) The deformation temperatures of SrO glasses are substantially lower than those for corresponding CaO glasses. b) The increase in deformation temperature caused by the substitution of SrO for SiO_2 is less than half as much as that produced by the substitution of CaO for SiO_2. c) The substitution of Na_2O for SiO_2 results in identical reductions in deformation temperatures in both SrO and CaO glasses. d) The substitution of Al_2O_3 for SiO_2 results in an increase of the deformation temperature; the corresponding increase in the CaO glasses is slightly less.

5) Density: a) The glasses containing 4 to 6% of SrO have approximately the same densities as the corresponding CaO glasses; as the RO content increases, the difference between SrO and CaO glasses increases, the SrO glasses having the higher densities. b) The substitution of SrO for SiO_2 results in very great increases in density; corresponding increases caused by substituting CaO for SiO_2 are markedly less. c) The substitution of Na_2O for SiO_2 results in marked increases in density; corresponding increases in the CaO glasses are appreciably less. d) The substitution of Al_2O_3 for SiO_2 increases the density of SrO glasses to a measurable extent more than does the same substitution in the CaO glasses.

6) Resistance to Distilled Water and Dilute Acid: a) The substitution of SrO for SiO_2 is very beneficial for resistance to both water and dilute acid. b) The substitution of Na_2O for SiO_2 greatly reduces the resistance both to water and dilute acid. c) The substitution of Al_2O_3 for SiO_2 is very beneficial for resistance to both water and dilute acid. d) The substitution of Al_2O_3 for SrO increases the resistance to both water and dilute acid. e) Strontium glasses containing 0.2% Al_2O_3 are markedly less resistant to both water and dilute acid than are the corresponding CaO glasses having 0.2% of Al_2O_3.

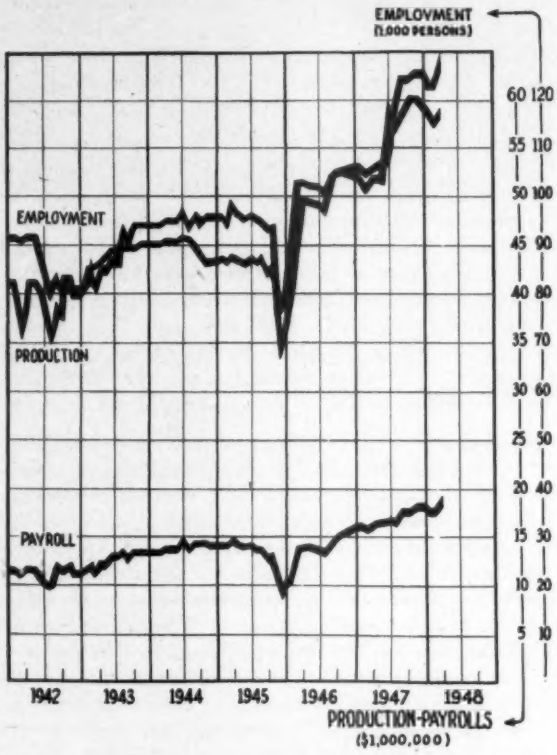
The Rate of Wear of Tank Blocks in Service

Several years ago, Dr. W. M. Hampton examined and discussed the temperature distributions in, and the heat losses from, the refractory sidewall blocks of glass tank furnaces. From these theoretical studies and from laboratory measurements of the rates at which various refractories were dissolved by molten glass, he was able to predict the form of the curve which related block thickness to length of furnace life. Hampton's views and conclusions have now been tested and extended by employing experimental data measured under commercial con-

(*Continued on page* 353)

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX



March 1948 activity in the glass industry, according to the Production Index, increased a little more than 5 per cent to an approximate $65,000,000. Activity during the previous month was an approximate $61,700,000. During the month of March 1947, production was estimated at $57,000,000, or about 14 per cent less than for March this year. Total output for the first quarter of 1948 has reached an estimated $188,400,000, or about 11 per cent over the output of an estimated $168,500,000 for the corresponding period in 1947.

Employment and payrolls: Employment during the month of March 1948 rose about 2 per cent to 117,800 persons. During the preceding month, employment was 115,000. Employment during March 1947 was 104,000 persons, or about 13 per cent below March this year.

An increase also occurred for payrolls during the month of March 1948 as they rose about 5 per cent above February's $17,500,000 to reach an estimated $18,500,000. Payrolls during March 1947 were an approximate $16,000,000 which is about 15 per cent below March 1948.

Glass container production, based on figures released by the Bureau of Census, continued to rise during the month of April 1948 to reach a production figure of 8,978,389 gross. This is about 1 per cent above the 8,851,340 gross produced during March. Production during April 1947 was 10,371,201 gross, which is about 13 per cent above production for March this year. Production during the first four months of 1948 has reached a total of 33,220,964 gross glass containers as compared with 41,381,821 gross produced during the same period in 1947. This indicates a difference of about 19 per cent.

Shipments for the month of April 1948 dropped to 7,811,641 gross after having reached the second largest shipment figure of 10,526,959 gross the previous month. This represents a difference of about 25 per cent. During April 1947, shipments were 9,982,640 gross, which is about 21 per cent above shipments for April this year. Total shipments made thus far in 1948 have reached 32,953,598 gross, as compared with shipments during the corresponding months in 1947 of 39,505,899 gross—

(*Continued on page* 336)

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in gross)

		Production April 1948	*Stocks April 1948*
Foods; Medicinal & Health Supplies; Chemicals, Household, Industrials; Toiletries and Cosmetics	Narrow Neck	2,797,760	2,594,912
	Wide Mouth	2,788,473	1,984,886
Dairy Products		305,586	226,021
Home Canning		178,344	736,417
Beverages, Returnable		1,057,859	807,049
Beverages, Non-returnable		.....	.....
Beer, Returnable		681,977	734,563
Beer, Non-returnable		251,775	220,481
Liquors		609,993	316,952
Wines		306,622	187,139
Packers' Tumblers		.....	58,219
Total		8,978,389	7,866,639

GLASS CONTAINER SHIPMENTS

(All figures in gross)

Narrow Neck Containers	*April 1948*
Foods	557,791
Medicinal & Health Supplies	1,087,046
Chemical, Household & Industrials	389,981
Beverages, Returnable	745,646
Beverages, Non-returnable	.....
Beer, Returnable	397,446
Beer, Non-returnable	210,156
Liquors	553,522
Wines	245,023
Toiletries & Cosmetics	312,349
Sub-Total (Narrow)	4,498,960
Wide Mouth Containers	
Foods	1,799,073
Dairy Products	338,666
Home Canning	275,089
Medicinal & Health Supplies	289,946
Chemical, Household & Industrials	83,209
Toiletries & Cosmetics	180,811
Packers' Tumblers	.....
Sub-Total (Wide)	2,966,794
Total Domestic	7,465,754
Export Shipments	345,887
Total Shipments	7,811,641

Photo courtesy Becton, Dickison Co.

HF *hydrofluoric acid*

Glass factories everywhere use Pennsalt hydrofluoric acid . . . and have found that it fulfills exacting requirements . . . from etching precision glass medical instruments to frosting, polishing and etching fine decorative glassware.

Pennsalt HF acid is furnished in strengths of 30%, 52%, 60%, 70% and 80% for domestic users. Strengths above 60% shipped in steel containers. Lower strengths in rubber drums. Write for full details. Heavy Chemicals Division, Pennsylvania Salt Manufacturing Company, Philadelphia 7, Pa.

Photo courtesy Cambridge Glass Co.

Photo courtesy Cambridge Glass Co.

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for the glass industry

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Aluminum Hydrate Ferric Chloride
Kryolith (Natural Greenland Cryolite)
Muriatic, Nitric, Sulfuric Acids
Salt Cake

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CURRENT STATISTICS . . .
(*Continued from page* 334)

a difference of close to 17 per cent.

Stocks on hand at the close of April were 7,866,639 gross, which is about 1,000,000 gross more than the 6,868,976 gross on hand at the close of March. Stocks on hand at the close of April 1947 were 5,442,586 gross.

Plate glass production for the month of April 1948, according to the Hughes Statistical Bureau, fell off very slightly from the all-time high established during March. April production was 23,416,518 sq. ft., as compared with 23,572,257 sq. ft. produced during the previous month. During April 1947, plate glass production was 21,419,088 sq. ft., which represents a difference of about 9 per cent from April this year. Total plate glass production for the first four months of 1948 has reached a total of 90,697,531 sq. ft., as compared with 86,271,503 sq. ft. produced during the corresponding period in 1947. This represents a difference of about 5 per cent.

Automatic tumbler production increased close to 4 per cent for the month of April 1948 to reach 5,422,209 dozens. Production during March was 5,222,513 dozens. During April 1947, production was 6,639,261 dozens. Shipments for April 1948 were 5,628,215 dozens, or about 6 per cent above the 5,313,986 dozens shipped during March. Shipments during April 1947 were 6,140,403 dozens. Stocks on hand at the close of April 1948 were 8,510,267 dozens; at the close of March, 8,659,354 dozens; and at the close of April 1947, 6,262,482 dozens.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware fell off about 10½ per cent for the month of April 1948; that is, 3,713,799 dozens sold during April and 4,146,736 dozens sold during March. During April 1947, 3,453,687 dozens were sold. Total manufacturers' sales for the 12-month period ending April 1948 were 42,638,683 dozens, as compared with 44,429,834 dozens sold during the corresponding period in 1947.

CORNING CANADIAN PLANT APPOINTMENT

The announcement of the election of John Carter as Vice President and Director of Corning Glass Works of Canada Ltd. has recently been announced. Mr. Carter will be in charge of sales and production at the company's Leaside, Ontario, Canada.

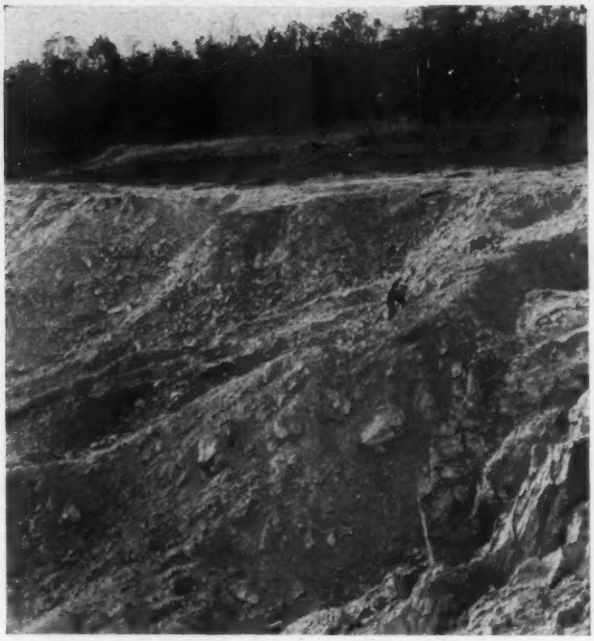
A graduate of Lafayette College, Mr. Carter served with the Army Air Forces for five years in the procurement and engineering section. Leaving military service in 1946, Mr. Carter joined the Hartford-Empire Company serving as Production Manager.

EDWARD WINTER AWARDED BINNS MEDAL

Edward Winter, internationally-known artist and originator of murals in enameled metals, was recently awarded the 1948 Charles Fergus Binns Medal of the American Ceramic Society for his distinguished work in the field of porcelain enamel art.

Millions of Tons of GLASS SAND

. . . For Your Oklahoma Plant!



Glass Sand in abundance! Sand of proven quality —SiO_2 of 99.83%. Sand that has helped produce quality glass products for years. These sand deposits are also bordered by huge deposits of quality limestone and dolomite, and supplies of soda ash, borax and feldspar are close by.

But raw materials aren't the only advantage of locating your plant in Oklahoma. There are 14 large glass plants located here, tapping the potential nine billion dollar Southwestern market from the center. Production costs are lower—because of abundant and low cost natural gas, native coal, oil, ample electrical power. Oklahoma also has many fiber box factories and foundries to serve you. Labor? One of the lowest strike rates in the nation!

Investigate ALL the advantages of locating a glass plant in Oklahoma. Because "facts* prove," Oklahoma's "OK" for the glass industry.

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"Factors favoring business expansion in Oklahoma.". Interesting—Informative. Write for it—Now! Special confidential report relating to your business will be made if requested.

PITTSBURGH PLATE INSTALLS STANDBY OIL-BURNING EQUIPMENT

To be prepared for any fuel shortage that would result in slowing or stopping glass production at its Creighton, Pa., plant, the Pittsburgh Plate Glass Company has recently completed installation of standby oil-burning equipment. The burners, supplying heat at about 3000-degrees F. for manufacturing glass, now have three sources of fuel—gas from company-owned wells, gas from a public utility and fuel oil.

One of the major problems that confronted the glass company's engineers designing the standby oil-burning equipment was finding adequate storage facilities for Bunker C oil. No space was available on the plant grounds to build a tank of sufficient capacity.

As the plant is located along the Allegheny River and has harbor facilities for unloading sand from barges, it was decided that the solution to the problem would be storing the oil in a barge. This also would answer the question of transporting oil to the glass plant. The barge could be towed to oil company docks, loaded and returned with a resultant substantial savings in transportation costs.

Steam heating coils, in a sinuous pattern, are installed in the bottoms of eight cargo tanks. Steam is supplied from the plant through a 4-inch main. The 3-inch oil discharge line on the barge is protected by a 1-inch steam chaser. On deck, the steam and condensate lines are in one conduit, the oil cargo and steam chaser lines are in another. Both conduits are encased in a larger one. Steam coils also are placed around the suction for each cargo tank. The existing 8-inch cargo discharge line, standard on the oil barge, is blanked off as it is used only during loading at the refinery. A by-pass is provided on shore to permit loading oil from tank cars to the barge through the regular 3" cargo line. Two piston-type 37 GPM electric pumps, with 550-V motors, are employed. The pumps are kept warm by steam chaser lines and are weather-proof and explosion-proof. Either pump can take suction from any of the eight cargo tanks.

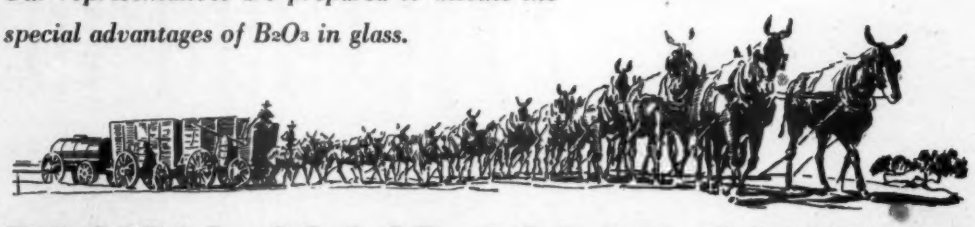
● Mr. Paul J. Burgun has been named sales representative for the Southern Ohio and Eastern Indiana territory of Knox Glass Associates, Inc., with a newly opened sales office at 74 East Gay Street, Suite 240, Columbus, Ohio.

BORAX

When included as a minor constituent in the container batch formula will justify its addition in improvements in the melting, fining, and forming operations as well as impart beneficial properties to the finished container.

• • •

Our representatives are prepared to discuss the special advantages of B_2O_3 in glass.



PACIFIC COAST BORAX COMPANY

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State of California
GOVERNOR'S OFFICE
SACRAMENTO

EARL WARREN
GOVERNOR

To American Industry:

In California we are currently celebrating the centennial anniversaries of the beginnings of our State. We gain much inspiration from our review of the progress which has been made in the comparatively short span of one hundred years.

During the past eight and one-half years alone California's population has increased by 47 per cent and our industry and agriculture have risen to positions of great importance in the economic life of the nation.

Our tremendous reserves of natural resources and our strategic world trade position on the shores of the Pacific Basin assure California's continued progress in the years to come.

I am happy, therefore, to join in inviting you to investigate the opportunities for expansion which exist in the many communities of our State.

Sincerely,

Governor

Earl Warren

* One of a series of advertisements based on industrial opportunities in the states served by Union Pacific Railroad.

Unite with Union Pacific in selecting sites and seeking new markets in California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, Oregon, Utah, Washington, Wyoming.

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Road of the Daily Streamliners

NEW EQUIPMENT AND SUPPLIES

BAUSCH & LOMB DEVELOPS SPECTROGRAPHIC ACCESSORIES

Bausch & Lomb Optical Company, Rochester 2, New York, has announced the development of five new accessories for use in spectrographic analysis. Designed by John W. Forrest, head of the firm's spectrographic design section, and his staff, the accessories include a densitometer, a spectrum plate projector, a safety arc and spark stand, an electrode shaper and a briquetting press, all of which may be used with any spectrograph regardless of make or design.

The densitometer permits direct reading and/or continuous recording of the density of the lines in an analytical spectrum for determining quantitatively any element present in the specimen.

Operated by a control panel, the instrument projects the lines to be measured onto a miniature screen. Each line is individually centered over an adjustable slit, and the light passing through the line reaches a photo-electric cell directly behind the screen. Current generated in the cell is then amplified and transmitted to a highly sensitive micro-ammeter scale for direct reading.

The spectrum plate projector aids identification of unknown elements in any specific material or specimen. A special mirror arrangement throws the spectral image on a screen built into the projector, or onto a wall screen if desired.

The spectrum of the specimen being analyzed may, in either instance, be easily compared with a known spectrum to determine alien elements present. The instrument's built-in screen is also adjustable to provide desired changes in magnification.

To insure complete protection in using the dangerously high voltages (two to ten amperes at 110 to 15,000 volts) needed to burn the specimen in the arc for spectrographic analysis, a safety arc and spark stand was also developed. The "live" parts of the circuit are encased in a cylindrical chamber. Thoroughly insulated, the chamber is inaccessible from the outside, except by means of a door, opening of which automatically breaks the electric circuit. The stand is equipped with a screening device capable of isolating that portion of the arc that is of particular value in analyzing the specimen.

The electrode shaper has a rotatable turret equipped with adjustable cutters, drills and tools for shaping graphite rods into the various standard electrodes used as arc and spark excitation sources.

The briquetting press compresses powdered drugs, chemicals, plant ashes, drill chips, hacksaw dust and the like, into pellets about the size of an aspirin tablet. The pellets can then be easily introduced into the graphite rods prepared on the electrode shaper for burning in the arc and spark stand. Operated manually, little effort is required to produce pressures up to 16,000 pounds to compress the material into pellets.

GERMICIDE FOR EQUIPMENT SANITATION

Willson Products, Inc., Reading, Pa., has announced a powerful germicide for sterilizing personal safety equipment and protecting workers from contamination through the use of such devices.

The germicide is a non-corrosive, non-staining solution which is practically odorless. Though about 25 times more powerful than carbolic acid, the germicide is non-poisonous and non-irritating to the skin. It also acts as a deodorant and fungicide. It may be used as a spray, swabbing solution or immersion solution for gas masks, goggles, welder's masks, respirators, safety shoes, boots or any washable apparel. It is effective in hot or cold water in the recommended concentration of 2 teaspoonsful to a quart of water, but users are cautioned not to mix the solution with soap.

RADIUS EXTENSION BAR FOR FLASH CIRCLE BURNER

Scientific Research Company, Box 137, 1618 N. Vancouver Avenue, Portland 12, Oregon, has created a new radius extension bar for the flash circle burner as an accessory named Special Extension Bar.

The bar is made of rigid cold-rolled steel, and the adaptor is permanently fixed to the bar by induction silver soldering. The unit is then cadmium plated to prevent rust. An aluminum set screw with cut threads is set diagonally on the adaptor, thereby creating a firmer hold on the joining bar.

The flash circle burner was developed to eliminate guesswork, save time and increase the utility of any flame cutting torch by making possible easy cutting of circles, curves and straight lines in plate. The special extension bar is quickly readied to cut circles up to 60″ in diameter, which, plus the 8″ length of the torch radius bar, equals 30″ possible radius with the use of one extension bar. Larger circles (to any diameter) can be accurately cut with multiple extension bars joined together.

CATALOGUES RECEIVED

Gehnrich & Gehnrich, Inc., 3232 57th Street, Woodside, L. I., N. Y., has announced the publication of a booklet, "How To Select The *Right* Oven For *Your* Process", which is said to be a new planning guide for production people concerned with heating, heat treating, baking or curing problems.

The 32-page manual discusses the four basically different types of oven heating systems, when to use which, the different heating media, temperature and safety control, insulation, the material-handling problem, interesting ingenuities, the action of different products under heat (chemically, physically, metallurgically, structurally), and the seven basic oven and heater types.

Convair Corporation, Pittsburgh, Pa., has issued Bulletin No. 101 featuring its pneumatic conveying systems.

The bulletin lists the advantages of a Convair system which is shown in line drawing. There is also illustrated by line drawing a batch conveying system for the glass industry with descriptive material concerning the operation.

The new bulletin also describes and illustrates other systems employing Convair pneumatic conveying equipment.

The Harshaw Chemical Company, 1945 East 97th Street, Cleveland 6, Ohio, has published a new 32-page booklet entitled, "Industrial Chemicals".

The booklet opens with an introduction giving facts of interest about the company and is followed with a number of aerial views of the main office and company plants.

Following this, various departments of the company are discussed briefly with suitable illustration. Running through the booklet is an alphabetical list of the industrial chemicals which are available through Harshaw Chemical Company.

Westinghouse Lamp Division, Advertising and Sales, Bloomfield, New Jersey, has announced the publication of Booklet A-3817 entitled, "Modern Baking, Drying, Heating with Industrial Infrared Lamps."

Described in the booklet is radiant heat processing for glass and bottling, food, metal-working, plastics, etc. Case histories are given to show how infrared cuts costs, speeds production and saves space wherever heat is required for dehydrating, finish baking or mass heating. A check list of applications for which it is now being used names more than 70 operations and processes in a wide variety of industrial plants.

American Cyanamid Company, Mineral Dressing Division, 30 Rockefeller Plaza, New York 20, New York, has released a bulletin "Coal Preparation-Heavy-Media Separation Processes and the Dutch State Mines Cyclone Separator Processes."

The O. Hommel Company, Pittsburgh, Pa., has published a catalogue entitled, "Porcelain Enameling Supplies." The catalogue lists prices of all supplies and equipment needed in enamel plant operation.

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WHEN YOU SPECIFY B&A REAGENTS

Wider Selection Means you can order virtually all your reagent chemical requirements from the same source, at the same time. This is the economical way . . . the time-saving, easier way. More than 1,000 purity products of Reagent A. C. S., C. P., U. S. P., N. F., and Technical grades carry the B&A "Shield of Quality" label.

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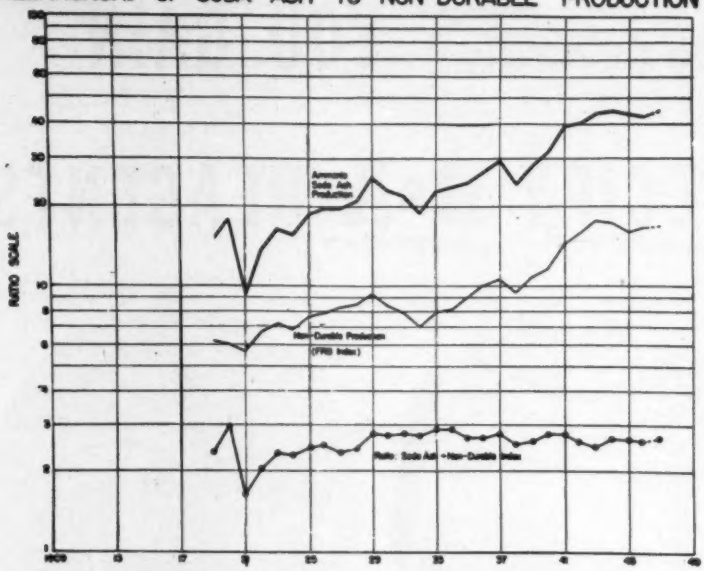
In Wisconsin: General Chemical Company, Inc., Milwaukee, Wis.
In Canada: The Nichols Chemical Company, Limited • Montreal* • Toronto* • Vancouver*

* Complete stocks are carried here.

FIG. 9

RELATIONSHIP OF SODA ASH TO NON-DURABLE PRODUCTION



CALCULATED BY MARKET RESEARCH DEPT., WYANDOTTE CHEMICALS CORP.
SOURCE: U.S. CENSUS BUREAU, CHEM. & MET. ENGINEERING.

the use of cullet and soda ash substitutes and increased use of natural soda ash, which is not included in these figures.

The National Economy

Commodities as old and well-established as glass and soda ash are bound to follow the rise and fall of our national business cycle. They may rise farther, fall slower, or otherwise deviate in degree but the direction is usually the same. The plot of soda ash vs. non-durable goods production bears out this statement fully. Since 1929 soda ash has paralleled the FRB Index, maintaining a ratio with a maximum of only 7% deviation. At present the ratio is 1% below the mean and only 7% below the peak ratio of 1934. This indicates that we have at least a 1% shortage of soda ash and at most a 7% shortage this year. This statistical conclusion seems logical to us in view of the well-known fact that even a slight shortage magnifies itself many times because of duplication of orders. It would seem that a 12-15% expansion of capacity would relieve the shortage—*if the national economy remains at its present level.*

Plotting glass production vs. the national income, we again find close correlation. Since 1910 the ratio has been nearly constant though glass has shown some tendency to grow faster than national income. It is significant that when the ratio gets far "out of line", it soon drops back. In 1920 glass production got ahead of the rest of the national economy and again in 1937. The 1933 to 1937 trend may have been due to stocking up brewers and bottlers with their initial supply of returnable bottles. The ratio seems to be out of line again now. By past precedent it would seem that only some revolutionary change (such as phenomenal success of the one-way beer bottle program) could lift the ratio much higher. Our prediction of a continued gain in 1948 is based on the continued high production of food for overseas, the shortage of tin and a substantial increase in the flat glass content of automobiles and houses.

The Forecast

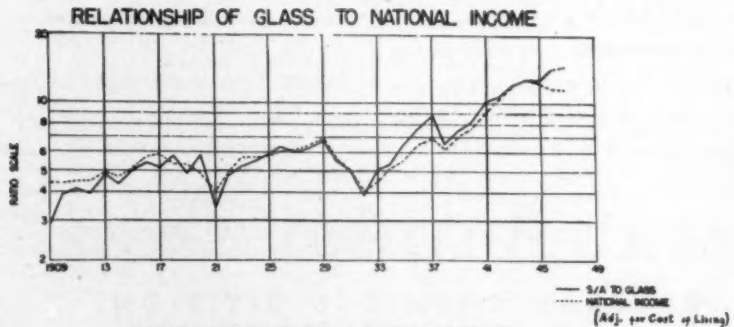
We have examined the past trends and interrelationship of soda ash, glass and national economic indexes. The safest move for me at this time would be to conclude with Lord Byron's famous line "The best prophet of the future is the past" and let it go at that. But I suspect you want me to tell you whether soda ash will continue to be short or not, whether you should invest heavily in substitutes, accumulate inventory whenever possible and continue to hold down the weight of bottles or proportions of soda ash in the batch. It is difficult to make such a forecast without being misinterpreted.

Throwing caution to the winds, we at Wyandotte venture to guess that soda ash will continue to be short for most of next year. We hope it will not be as short as this year. During the early months glass plants may be hampered by other shortages, mainly fuel, but we expect record demands in the second and third quarters. The fourth quarter will probably bring the normal seasonal slump—possibly accentuated by a bursting of the inflation bubble. But we are inclined a bit to doubt that

(*Continued on page* 344)

FIG. 10

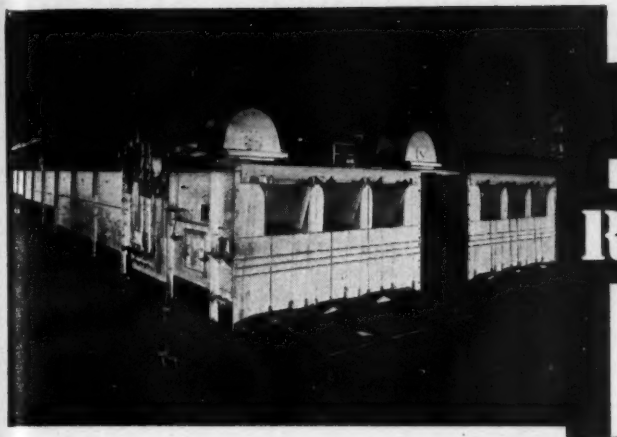
RELATIONSHIP OF GLASS TO NATIONAL INCOME



RATIO: S/A TO GLASS / NATIONAL INCOME

CALCULATED BY MARKET RESEARCH DEPT., WYANDOTTE CHEMICALS CORP.

Take Advantage of



CONTROLLED RECIRCULATION

There are certain definite advantages in recirculating the heated gases under complete control to the critical annealing zones of a continuous lehr. This plan assures maximum uniformity in the finished product. Width of belt and tunnel height are not controlling factors. It requires less fuel and lowers annealing costs. It provides greater flexibility than other methods of heating and far more accurate control of temperatures in both heating and cooling zones.

2596

Controlled Recirculation is an exclusive feature of Surface Combustion Continuous Lehrs.

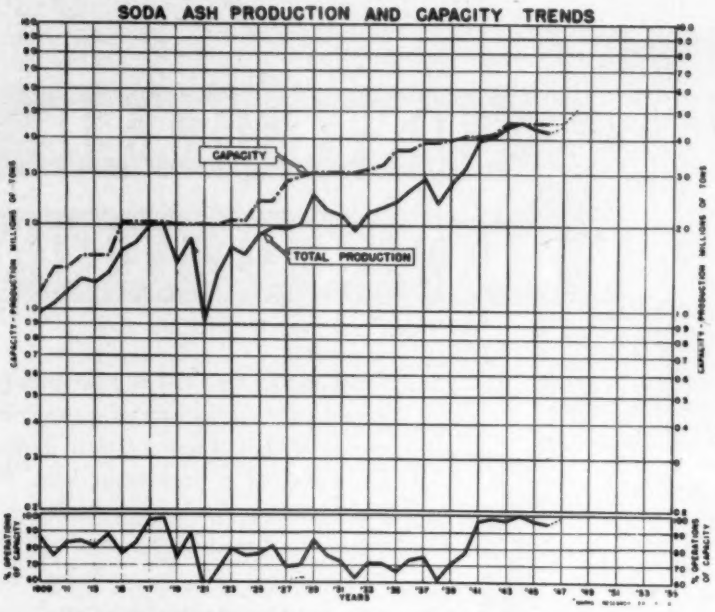
Write to Surface Combustion engineers for specific information.

SURFACE COMBUSTION CORPORATION

TOLEDO 1, OHIO

OUTLOOK FOR SODA ASH . . . (*Continued from page* 342)

FIG. II



CALCULATED BY MARKET RESEARCH DEPT., WYANDOTTE CHEMICALS CORP.

1948 will see the beginning of the much-advertised but hard-to-find bust. When it does come, we have no doubt that glass and soda ash will have their share of depression. Glass has been held back somewhat from inflated demand in recent years by shortage of soda ash. The current expansion will be sufficient, in our judgment, to allow glass to extend itself well beyond the normal ratio to national income. Thus when the fall comes, it may well be more precipitous for glass than for national income. Soda ash will of course share that drop.

Speaking of capacity, the soda ash industry need not be too concerned about capacity being too great after the present expansion. The next and last chart shows the trend of capacity versus production since 1909. The industry has normally operated in the range of 70 to 80% of capacity. During the two wars the rate went up to 100%. We stayed at peak rate longer during this war for several reasons: 1) there was less expansion immediately preceding the war, 2) there has been little accumulation of war inventories of soda ash this time, and 3) the deferred demand for consumer goods was greater after this war.

It will be noted from this chart that the production growth trend has been at the rate of 4.3% per year whereas the capacity growth has been only at the rate of 3% per year since 1919. Therefore, we can reasonably conclude that the expansion being built now was needed by the industry merely to provide for normal growth without regard to the incidence of war. Should demand follow the trend line we would have a slight surplus of soda ash late in 1948 —about 7 or 8%—allowing a return to a more desirable factor of plant operation. Should we suffer a drop in demand to the 1941 level—which would be a major depression by present day standards—production would still be 80% of capacity—a rate we used to consider optimum. The significant figures to soda ash consumers are that production capacity is being increased over 1947 production levels by 15% and the production available for sale is being increased by 20%. Because of the length of time required to build new soda ash facilities, it is hoped that this amount of expansion will suffice until the present construction boom is over and costs return to more normal levels.

FELIX WUNSCH RETIRES FROM LEEDS & NORTHRUP

Felix Wunsch, a veteran of the engineering staff of Leeds & Northrup Company and inventor of numerous circuits widely used in electrical measuring instruments has recently retired, according to an announcement.

Mr. Wunsch, who has spent nearly 43 years with Leeds & Northrup, has had patents issued on 12 designs which have proven valuable to the industry. A thirteenth patent is now applied for.

Joining the firm in 1905, Mr. Wunsch first worked in the laboratory making electrical instruments. In 1909 he was named assistant foreman in the laboratory, later becoming assistant to the chief engineer in the engineering department, then technical advisor to the department.

Mr. Wunsch's first inventions were a split-circuit potentiometer and an automatic reference-junction compensator for that circuit. The combination is used principally to measure high temperatures and is considered one of his most important contributions.

AMERICAN POTASH STOCKHOLDER REPORT

Production and sales of American Potash & Chemical Corporation attained an all-time high in 1947 and income increased approximately 40 per cent, it was announced at the annual meeting of the company's stockholders.

The Board of Directors of the company, at a regular meeting held the same day, declared a dividend of 37½¢ on the Class A and B stocks and a quarterly dividend of $1 a share on the $4 cumulative preferred stock, Series A. Both are payable next June 15 to stockholders of record on June 1, 1948.

Output of chemicals at the company's plant at Trona, California, totaled 594,764 tons in 1947, a record figure. Sales totalled $13,637,700, compared with $10,738,368 in 1946. After deducting dividends of $206,111 on the 70,000 shares of $4 cumulative preferred stock sold in March 1947, earnings on Class A and B stocks amounted to $1,900,208, equivalent to $3.60 a share, compared with $2.87 in 1946.

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ANNUAL MEETING OF G. C. M. I. . . .

(*Continued from page* 315)

June 1, 1948 of the powers of the Commerce Department to limit the use of tinplate for packaging certain products as set forth in the revision to Can Order M-81.

As in the case of so many industries, the glass container manufacturers have been concerned with the status of the trade treaty program as it affects their industry. Following the granting of concessions and the signing at Geneva of the General Agreement on Tariffs and Trade by twenty three nations, the President by proclamation on December 16, 1947, declared the agreement in effect January 1, 1948, with certain exceptions. Although the new regime in Czechoslovakia has reversed the stand of the former regime and has ratified the Agreement in order to obtain the concessions granted, the State Department appears undecided as to whether to recognize such ratification.

Another matter discussed by Mr. Gayner was that his Committee, on behalf of the industry and in connection with negotiations for the revision of the Mexican Trade Agreement, presented to the Committee on Reciprocity Information a formal brief protesting against the abrogation by Mexico of the existing treaty. Mexico had placed restrictions and embargoes on many products, including glass containers under 400 grams, and had given notice of intention to raise import duties on practically all products.

Continuing on the subject of international trade, Mr. Gayner spoke of his Committee's request of the State Department, on behalf of the industry, to protest the discriminatory provisions of a certain Cuban decree regulating and restricting the relationship of foreign firms and their agents in Cuba. This protest, also made by several other industries, was in fact made to the Cuban Ministry and the provisions of the decree are now being held in abeyance pending negotiations.

Since the last meeting of the Glass Container Manufacturers Institute, real progress has been made by the Committee on Market Research and Promotion, headed by L. J. Collins, Chairman of the Board of Anchor Hocking Glass Corporation.

Mr. Collins pointed out that the all important matter of an appropriation to implement the industry's promotional plans had been achieved and the team that will develop and execute the program had been assembled.

The first member of the team to be introduced to the assembled glass men was Benjamin Wood, the Institute's recently appointed Director of Marketing. Mr. Wood spoke briefly on the big job that lies ahead in marketing and promotion, then introduced other members of the corps who will carry out the work. Present at the meeting were Fairfax Cone and two associates of Foote, Cone and Belding, the advertising agency which has been selected to handle the industry's advertising, Burns Roper of Elmo Roper Associates, who will specialize in market research and Theodore Swanson of Theodore Swanson & Co., who is in charge of public relations.

A golf tournament, an informal dinner and a bridge party for the ladies comprised the main features of the social activities. A highlight of the business sessions was a talk delivered by Martin R. Gainsbrugh, Chief Economist, National Industrial Conference Board, on the Trends in Our Industrial Economy.

BORIC OXIDE—ITS CHEMISTRY AND ROLE IN GLASS TECHNOLOGY . . .

(*Continued from page* 329)

heights of the energy barriers across which they have to jump. (Activation energy) It seems that the more deformable ions have a lower energy of activation than noble-gas-like-ions of the same charge and size. The jumping from one position to the next possible position becomes more difficult if the latter is occupied by a different ion.

PPG AND L-O-F SETTLE WITH C.I.O.

The Libbey-Owens-Ford Glass Company and the Pittsburgh Plate Glass Company have announced the successful conclusion of collective bargaining negotiations with the Federation of Glass, Ceramic & Silica Sand Workers of America, CIO. The announcement was made by Sylvester Garrett, Labor Relations Coordinator for the companies.

The new agreement is for the period May 1, 1948 to May 1, 1949, and covers close to 20,000 workers represented by the Federation in the plants of the companies. The union was represented in the negotiations by Joseph Froesch, International President and its National Wage Committee.

The new contract continues in force all of the mutually satisfactory provisions contained in the previous contract including a no-strike and no-slowdown clause. In the light of current developments, the union and the companies agreed to extend the wage schedule of the last contract. The new contract stipulates that the wage question can be reopened only after sixty days and only once during the life of the contract. It was further agreed that in the event the wage issue is reopened, and the companies and the union fail to agree, the wage question would be settled by arbitration.

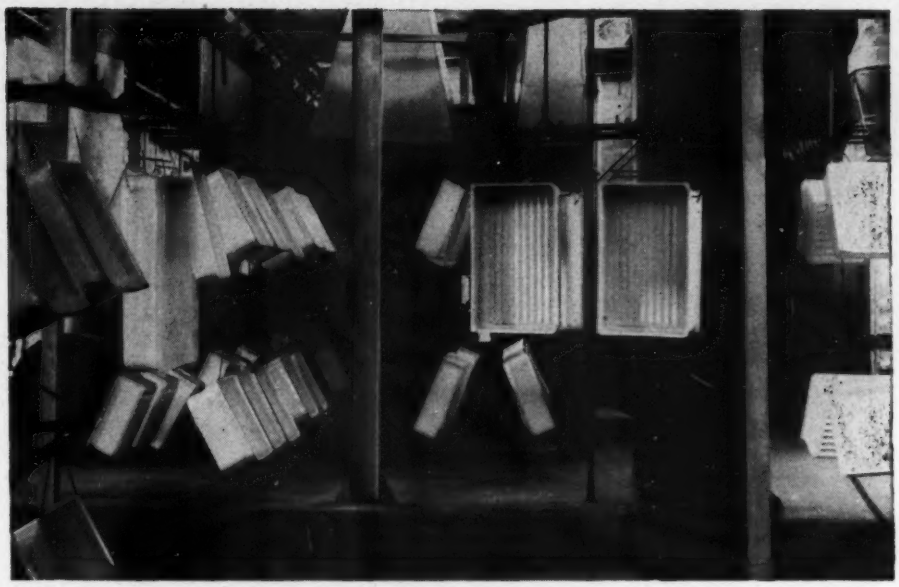
The settlement provides that the companies will absorb the total cost of premiums for insurance which in the past have been paid for on a partial contributory basis by the employes. The insurance program includes group life insurance up to a maximum of $2,000 per year, hospitalization insurance for man and wife, and reasonable health and accident insurance benefits.

Negotiations leading up to the settlement were commenced on April 20, 1948. Libbey-Owens-Ford was represented in the joint negotiations by L. G. Bryan, Vice President in charge of production.

DAVID GOODWILLIE REPRESENTS CORNELL AT INAUGURATION

David H. Goodwillie, Executive Vice President of Libbey-Owens-Ford Glass Company, represented Cornell University at the inauguration of Dr. William Wallace White as the eighth president of the University of Toledo. Mr. Goodwillie received his ME degree from Cornell in 1908.

In the inaugural address Dr. White said the municipal university owes it to the city to ask whether "we have any local opportunity that is unique." One answer to that query in Toledo he said has been the establishment of a curriculum in glass technology appropriate to the "glass capital of the world." He suggested thought be given to similar opportunities in lines closely associated with other large industries of Toledo.



Porcelain-enameled ware leaving Gas-fired continuous oven in which porcelain is fused on steel.

CONTINUOUS GAS FURNACES

Expedite Porcelain-Enamelling Operations

Continuous GAS furnaces, installed in the production lines, expedite finishing operations at Strong Manufacturing Company, Sebring, Ohio. In this finishing cycle, porcelain enamel is fused on steel as the press-formed units pass through high-temperature chambers.

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PITTSBURGH PLATE APPOINTMENTS

Pittsburgh Plate Glass Company has announced the appointment of Miles S. Wright as Superintendent and Charles E. Stroud as Assistant Superintendent of its new "Twindow" plant at Creighton, Pa.

Mr. Wright joined the firm in 1930 as a plant engineer specializing in development and maintenance problems at the Crystal City plate glass plant. In 1940 he was promoted to assistant department superintendent. During the war years, Mr. Wright was in charge of plant operations relative to aircraft glass contracts.

Mr. Stroud has been associated with the firm since 1925. He has held the positions of construction foreman, apprentice assistant foreman at the Ford City plate glass plant and general foreman of the double glazing department.

L-O-F ISSUES CURVED WINDSHIELD MANUAL

A small manual for replacement of the new curved safety plate glass windshields has been printed and is now being distributed in limited quantities through distributors of Libbey-Owens-Ford Glass Company.

Two special tools are recommended for the removal of windshield wiper mechanism and for "zippering in" rubber moldings.

The educational pamphlet indicates that most of the removal and installation work proceeds from outside the car. L-O-F bent Hi-test safety plate glass windshields are factory installed on 1948 Cadillac and Oldsmobile cars.

BROWN INSTRUMENT EXPANSION PLAN

Brown Instrument Company has announced a $2,500,000 expansion program which will add more than 60 per cent to its present manufacturing space and a proportionate increase in employment.

The program includes construction of a four-story addition to the main plant which will enable the company to combine some of its outlying leased sites and simultaneously provide needed space and production facilities to keep pace with the present high levels of business.

OWENS-ILLINOIS NAMES PACIFIC COAST MARKET DEVELOPMENT MANAGER

The appointment of Earl D. Steimer as Pacific Coast Market Development Manager has been announced by Owens-Illinois Glass Company.

Mr. Steimer joined Owens-Illinois Glass Company in July 1946 as Field Supervisor. He had formerly been associated with Adohr Milk Farms and Andrew Williams Stores.

CANADIAN SURVEY REPORT

The Canadian government has reported that a nation-wide survey shows that the average weekly wages in the glass products manufacturing industry amounted to $37.31 on February 1, 1948, as against $31.74 on February 1, 1947. The average hourly earnings reported were 81.1¢ on February 1, 1948, as compared with 71¢ on February 1, 1947, with the average hours per week 46 on February 1, 1948 and 44.7 on the same date in 1947.

*1907 was a great year . . .
and 1941 was the year
United States entered World War 2

In 1941 London suffered the worst air raid of the war . . . Germany invaded Russia and Japan attacked Pearl Harbor without declarations of war . . . United States then declared war on Japan, Germany and Italy.

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(*Continued from page* 321)

compared to the $Na_2O \cdot 3SiO_2$ base glass, it was found that both increased the viscosity.

When these same alkaline earth oxides were substituted for SiO_2 in the $Na_2O \cdot 3SiO_2$ base glass, CaO increased the viscosity while the MgO had little or no effect except at higher temperature where the viscosity was slightly decreased. These substitutions made in a soda-alumina-silica glass had the same quantitative effect, indicating that the presence of Al_2O_3 in the glass had no effect on the separate action of CaO or MgO, whether they replaced Na_2O or SiO_2.

The alkaline earth oxides CaO, MgO, SrO, and BaO were introduced into the $Na_2O \cdot 3SiO_2$ base glass in such a manner that the $\frac{Na_2O}{SiO_2}$ ratio remained constant at $\frac{1}{3}$. It was found that CaO increased the viscosity of the base glass the most, MgO had less effect but still increased it, SrO had a slightly less effect than MgO while BaO decreased the viscosity at all except the lowest temperature.

A definite non-additivity behavior is shown by the effect of a mixture of CaO and MgO together when these alkaline earths replace Na_2O in the binary base glass. A minimum is observed in viscosity when 4% of the CaO is replaced by MgO. When a mixture of these alkaline earths replaced SiO_2, the resulting change in viscosity was as would be predicted.

A similar study was made of the effect of mixing the alkalies, Na_2O and K_2O. It was found that while the $Na_2O \cdot 3SiO_2$ equivalent $K_2O \cdot 3SiO_2$ glass, a $K_2O \cdot Na_2O \cdot 6SiO_2$ glass had a considerably lower viscosity than either of the binary end glasses.

If Al_2O_3 was substituted for either Na_2O or SiO_2, an increase in viscosity resulted. This increase was greater if the Al_2O_3 replaced Na_2O.

From the experimental data, it was possible to develop constants which can be used to predict the viscosity of ternary and quaternary phases within ±1%. Figure 7 shows an isothermal diagram developed from these data.

It was concluded that the effects of various oxide constituents on the viscosity in soda-lime-alumina-silicate glasses are additive to a first approximation, but this is not the case for glasses containing mixed alkalies or alkaline earths.

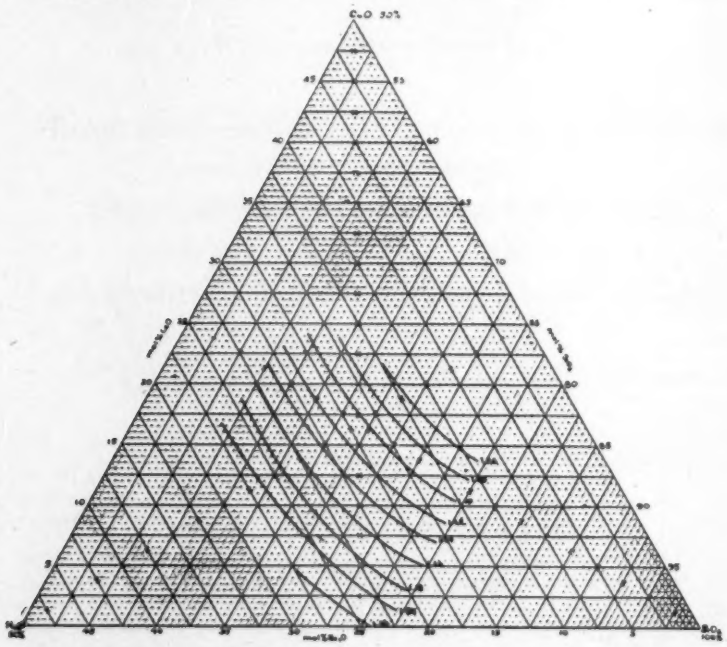

Fig. 7. Isothermal Lines at log n 10. System, Na_2O-CaO-SiO_2. To compute $\frac{1}{T}$ for any Na_2O-CaO-Al_2O_3-SiO_2 glass, at log n 10, add % Al_2O_3 to Na_2O and find $\frac{1}{T}$ for this three-component glass from the diagram. Then multiply % Al_2O_3 by .0155 and subtract from $\frac{1}{T}$ previously found.

Nuclear Physics and the Ceramic Industry. *By J. R. Johnson, Dept. of Ceramic Engineering, Ohio State University, Columbus, Ohio.*

A brief summary of the latest ideas on the particles and forces of basic matter was first presented. As an example of how radioactive isotopes can be used as tracers in ceramic research, the author described the procedure he is using in a study of the rate of diffusion of sodium ions into glass at various temperatures. A small glass rod is wrapped in platinum foil and placed vertically in a crucible filled with alumina powder so that it will be supported and will retain its shape at temperatures above the softening temperature of the glass. Approximately 0.02 mg. of radioactive sodium carbonate is placed on the protruding end of the glass rod. The rod is then placed in a furnace and exposed to the desired time-temperature conditions. It is immediately removed after the firing process and studied for the amount of diffusion which has taken place. This is done by removing successive thin layers from the rod by grinding its radioactive end on microscope slides covered with abrasive and measuring the activity of each slide in a Geiger counter. A graph is made showing the activity per unit mass of glass removed versus the depth of penetration. Self-diffusion and interdiffusion of metals have been studied in a similar manner. The radioactive isotope is first vapor plated or otherwise deposited on the specimen and after the desired experimental procedure has taken place, thin sections are machined off and examined.

Some suggested uses for radio isotopes in ceramic research included the following: 1) Diffusion and reaction studies. 2) Volatilization studies such as the loss of selenium from a glass batch. 3) Coating thickness control such as the thickness of gold or platinum on ceramic ware. 4) Study of mixing problems. 5) Determination of relative values of absorption tests and other absorption studies. 6) Automatic specific gravity control (patented). 7) Studies of flow of gases and liquids. 8) Possible automatic furnace control method. 9) Study of surface problems such as the surface deteriorization of glass. 10) Indicator for positions of concealed floats or materials which could otherwise be detected only with X-rays or radio apparatus.

A partial list of radio isotopes available from the United States Atomic Energy Commission was also given.

Application of Rate-Process Theory to Breaking of Glass. *By F. B. Hodgdon, D. A. Stuart and F. E. Bjorklund, Dept. of Ceramics, University of Utah, Salt Lake City, Utah.*

In 1943, Tobolsky and Eyring pointed out that in all unit processes of deformation, stress produces a two-fold effect on rate of strain. There is, first of all, an elastic component for which the rate of strain varies linearly with rate of stress and, secondly, a contribution to the rate of strain by "relaxation" processes. The latter can be readily measured for rubber, plastics and metals, but data on ceramic materials are meager. Stress-strain, and similar relationships can be derived in many ways, but it is simplest to derive them by the use of models in which the elastic component is represented by a pure

spring and the "relaxation" process by a spring-dash pot combination.

F. W. Preston and his co-workers have recently provided data on the ultimate strength of glass and procelain as a function of time under load over a wide range of time. Because of the nature of these data, it was possible for the authors to apply to glass and other ceramic materials this rate process theory of plastic flow. (Minor modifications of the original mathematical treatment were necessary, probably because of inherent differences between glass and fibres. The authors stated that these modifications do not affect the rigor of the mathematical derivation, but that the physical reasons for them are still obscure and are a basis for future study.)

After the development of suitable equations, the data of Preston was compared with the mathematical calculations. The breaking equation fits the data very well, while the values obtained for the free energy of activation also appear reasonable since they are of the same order of magnitude as the strengths of alkali-oxygen and alkaline earth bond strengths in glass as determined by other methods. The simplified model used here could not be used in the analyses of the temperature dependence of properties such as viscosity and birefrigence. (The study of those properties by this method is now under way by the authors.)

The application of the Eyring formula leads to several interesting implications regarding the properties of glass. It shows that 1) these glasses and possibly others at room temperature will be under a combination of tension and compression forces at times. An external load will relieve part of the compression and the maximum elongation takes place before stress relief appears, 2) the breaking equation predicts that failures in glass will be failures in tension, and 3) the brittle nature of glass can be explained in a qualitative manner.

PITTSBURGH PLATE MODEL STORES ON TOUR

Models of the new "open front" stores, prototypes of the visual, scientifically lighted and functionally color styled commercial shops, had their first showing in New York City recently.

Designed by Pittsburgh Plate Glass Company's department of architectural design, the model stores are constructed to one-eighth scale with the displays being executed in minute detail. The models shown can be used as basic designed by architects for any locality in the United States, it is stated.

Following the showing in New York, the models mounted in specially constructed trailers will move to Philadelphia, starting a 250,000 mile tour planned during the next three years.

According to Elmer A. Lundberg, Director of architectural design for the firm, stated, "Architects throughout the nation are becoming increasingly conscious that 'display' is one of the most important words in any merchant's vocabulary. Display of the entire merchandising area on the street level is what the merchant wants. And it's what he gets in the 'open front' type of store. His entire establishment on the street level becomes a glass enclosed showcase.

HEAT CONDUCTING GLASS DE-ICES WINDSHIELDS

Libbey-Owens-Ford Glass Company has announced the development of a heat conducting glass which has been put to use for de-icing windshields. Glass normally is used as an insulator, but it becomes a conductor of electricity by coating it with an invisible film.

Higher voltage than is normally found on the average family automobile is required for efficient operation of the de-icer. The most feasible method of supplying current, according to the research staff, is to replace the conventional generator with an AC generator. The AC current then can be transformed to voltages sufficiently high to perform the necessary de-icing operation.

Rate of heating the glass depends entirely upon the voltage that is through into the film. R. A. Gaiser, one of the researchers, in his experiments installed an AC generator and used 110-volt current. He pointed out that the glass "heats rapidly" with such equipment, acting as a barrier to the formation of ice and quickly melting ice already formed. In one test in six-below zero weather, starting with his windshield completely coated with ice and driving at 50 miles an hour, Mr. Gaiser noted that the windshield was completely de-iced in "less than five minutes".

The principle behind the development was to heat glass by a continuous electric current. To accomplish this, the research men tried various coatings and finally determined upon a composition that is basically stannic oxide and is formed with any number of tin compounds. Electric current is fed to the film-coated surface through electrodes sandwiched between two pieces of ordinary glass. A controlled electrical current flows freely through the film and spreads evenly over the entire surface with no resulting "blind spots".

B&L PRODUCES ASTRO-WINDOW

A new astro-window through which navigators aboard long range stratosphere airliners will "shoot" the stars, even in daytime, has been developed by Bausch & Lomb Optical Company.

Designed for Air Force and commercial ships, the streamlined "window" consists of two plates and is capable of withstanding a total force of three and one-half tons. Its surface projects only two and one-half inches above the ship's skin as compared to six inches in the old type, speed-retarding astro-domes.

The astro-window's outer plate is a large optical lens that has been ground and polished to reduce refraction errors regardless of the angle of the sighting instrument. The inner plate is plastic and houses a defrosting system that should prove "invaluable to celestial navigators," according to its designer, Edward F. Flint, of Bausch & Lomb's Scientific Bureau.

INVENTIONS AND INVENTORS . . .
(*Continued from page* 331)

this patent: United States Patents: 2,215,039, Hood, Sept. 17, 1940; 2,299,827, Koester, Oct. 27, 1942; 2,337,460, French, Dec. 21, 1943; and 2,348,704, Adams, May 16, 1944.

American Optical Company Refractory. Fig. 4. Patent No. 2,440,187. This patent was assigned to the above company by Carl G. Silverberg of Brookfield, Mass. The invention relates particularly to a refractory and method of making it, suitable for the support and shaping of glass articles during the heating and dropping so that the glass conforms to the shape of the support. This material prevents sticking and facilitates the heating operation.

Fig. 4. American Optical Company Refractory.

It has been common in the past to make blocks of this kind from silicon carbide which worked fairly well at low temperatures but did not work so well at higher temperatures. It was often necessary to dust the surface of the block with clay or graphite which did not produce good results. This invention overcomes those difficulties and also provides many other advantages.

The major ingredient used in this new refractory is kyanite. One of the various ball clays may be added with advantage. The addition of sodium silicate and sodium carbonate may also be of advantage. One of the preferred compositions is as follows:

	Grams	Approximate Parts by Weight
Kyanite	3,200	8,000
Ball Clay	800	2,000
Sodium Carbonate	4	10
Sodium Silicate	8	20
Triethanolamine	2	5
Water	1,000	2,500

Other dispersing agents which may be used in place of those given are morpholine, lignin, tannic acid, etc.

The recommended composition is as follows:

Kyanite	grams..	2400
Ball clay	do...	300
Chrome oxide (green)	do...	300
Sodium carbonate	do...	4
Sodium silicate	do...	8
Triethanolamine	cc..	2
Water	grams..	1000

The method of making the refractory is given as: a) Dissolve one or more of the dispersing agents in the required amount of water. b) Mix the required amount of ball clay very thoroughly. c) Add the colorant or infrared absorbing material. Green chrome oxide is recommended. d) Add kyanite to make a smooth mixture. e) If desired, add a small amount of triethanolamine.

GLASS MACHINERY COMPANY

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This mixture is then milled in a ball mill for 70 to 80 hours after which it is ready for use. A plaster of Paris mold having a cavity of the desired shape is then filled. If a solid block is desired, the entire mass is allowed to set but if a hollow form is to be made, the fluid remaining after 15 minutes may be poured off. This is the usual slip casting method and leaves a cavity 10 as shown in Fig. 4. The block is then removed from the mold, dried and then fired to a temperature of 2200°F. The use of this refractory gives much better results than has been possible heretofore. The dropping operation is carried out in the usual manner.

The following references are of record in the file of this patent: United States Patents: 94,726, Eaton, Sept. 14, 1869; 637,635, Mersch, Nov. 21, 1899; 700,673, Buchner, May 20, 1902; 1,081,536, Jeppson, Dec. 16, 1913; 1,292,953, Jeppson, et al., Jan. 28, 1919; 1,631,695, Riddle, June 7, 1927; 1,682,675, Horsfield, Aug. 28, 1928; 1,712,005, Lambie, et al., May 7, 1929; 1,716,395, Trostel, June 11, 1929; 1,760,360, Hood, May 27, 1930; 1,769,297, Lambie, et al., July 1, 1930; 1,812,376, Ross, et al., June 30, 1931; 1,856,613, Ackermann, May 3, 1932; 1,897,183, White, Feb. 14, 1933; 1,909,785, McDougal, May 16, 1933; 1,942,879, Riddle, Jan. 9, 1934; 2,079,715, Pole, May 11, 1937; 2,159,349, Bennett, May 23, 1939; 2,160,873, Kerla, June 6, 1939; 2,207,558, Singer, July 9, 1940; 2,270,607, Ryschkewitsch, Jan. 20, 1942; 2,272,039, Morgan, Feb. 3, 1942; 2,308,473, Wadman, et al., Jan. 12, 1943; and 2,331,232, Ross, Oct. 5, 1943. Foreign Patents: 676,595, Germany, 1939.

RESEARCH DIGEST . . .

(*Continued on page* 333)

ditions on large-scale glass melting tank furnaces. The results of this work are reported by Whittaker and Seddon in the October-December 1947 issue of *The Journal of the Society of Glass Technology*.

Using a specially designed water-cooled gauge, the rate of wear (at points various depths, usually 2 in. below the glass surface) of refractories in the sidewalls of tank furnaces melting colorless glass was measured at intervals throughout five complete furnace lives. Experimental observations were made on fusion-cast mullite, on sillimanite and on fireclay tank blocks, not all of the same original thickness, in furnaces operated at various levels of temperature and melting under different glass loads. Rates of wear were determined under conditions of natural cooling and also when high-velocity, forced air cooling was applied.

From an analysis of the data obtained and as predicted by Hampton, an approximately linear relation was found to exist between age of furnace and the block thickness measured at a point 2 in. below the glass surface; the wear deviated from the straight-line relation and diminished appreciably when the blocks reached a thickness of 3 in. or 4 in.

The fusion-cast blocks showed more resistance to wear than the two types of sillimanite. The latter in turn were superior to the fireclay blocks in the service trials made to date. When forced air cooling was applied, the rate of wear appeared to diminish in two observed cases of fusion-cast, and of fireclay refractories, the drop in rate

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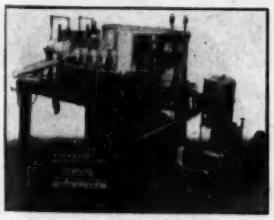

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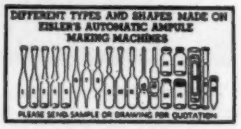
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of wear being greater in the case of the fusion-cast material. High velocity, forced air cooling exerted a measurable influence through some 10 in. of fusion-cast block. (See Table I)

TABLE I

EFFECT OF FORCED COOLING ON RATES OF WEAR

	Fireclay	Forced-cast Mullite
Rate of wear with natural cooling, in. per week	0.39	0.30
Rate of wear after forced cooling applied, in. per week	0.20	0.06
Age when forced cooling was applied, weeks	2½	7
Thickness when forced cooling was applied, in.	11	10
Original thickness, in.	12	12

Lower rates of wear definitely appear to result from lower operating temperatures. (This effect should not be confused with the lower rates of wear that accompany the thinning of the blocks.) In discussing the effect of varying the glass load on the rate of wear, the authors state, "although we might have expected the highest glass loads to be associated with higher rates of wear of the sidewall blocks, there is very little positive evidence of expectation being fulfilled, probably because the presence of other more potent factors, such as varying operating temperatures, changing block thickness, etc."

Mean thicknesses of sidewall blocks in the melting end at the conclusion of a period covering several furnaces' lives were quoted (actual measurements in cold furnaces). In general, this data showed the superior behavior of fusion-cast mullite and of slip-cast sillimanite refractories over fireclay when melting colorless bottle glass.

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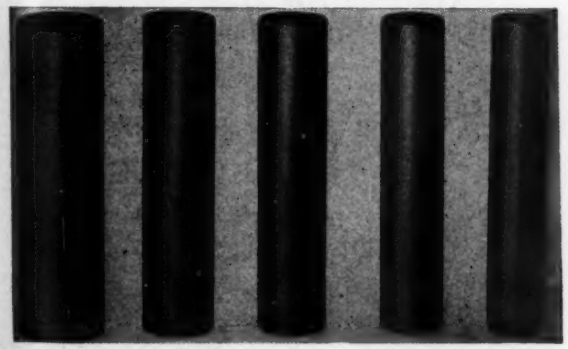
DU PONT STOCK REPORT

E. I. du Pont de Nemours & Co., Inc., was owned by 93,423 different stockholders as of March 31, an increase of 2,222 over the number of holders recorded at the close of the last quarter of 1947 and an increase of 5,649 over the number of holders as of March 31, 1947.

There were 76,002 holders of common stock and 23,450 holders of preferred stock as of the first quarter of 1948 ended. These figures include 6,029 holders of more than one kind of stock.

GUNITE



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GLASS SCIENTIST TO VISIT TOLEDO

Dr. W. M. Hampton, newly elected President of the British Society of Glass Technology, who has recently arrived in Canada, has included a visit of several days in Toledo. Dr. Hampton is a Director of Chance Brothers & Company, English glass manufacturers.

PITTSBURGH-CORNING ESTABLISHES DEVELOPMENT GROUP

The establishment of a new Product Development Group by the Pittsburgh Corning Corporation has been announced. The new organization was formed to coordinate sales and research activities in the interest of better service to Pittsburgh Corning customers.

Dr. A. H. Baker, former Director of Research and Engineering for the firm, has been designated Technical Director and will be responsible for all research, development and engineering activities.

DIAMOND ALKALI STOCK REPORT

Net income of the Diamond Alkali Company for the first quarter of 1948 totaled $1,054,000, after federal taxes, as compared to $1,093,000 for the comparable period in 1947, Raymond F. Evans, President of the firm, reported at the company's annual meeting of stockholders.

Net sales of the company for the first quarter were $10,694,000, as compared with $8,575,000 for the same period in 1947, or an increase of approximately 25 per cent.

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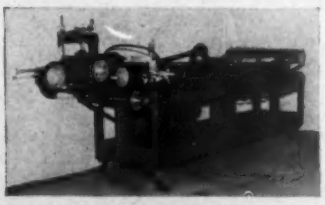

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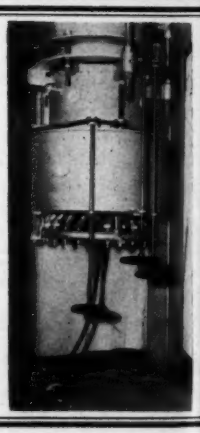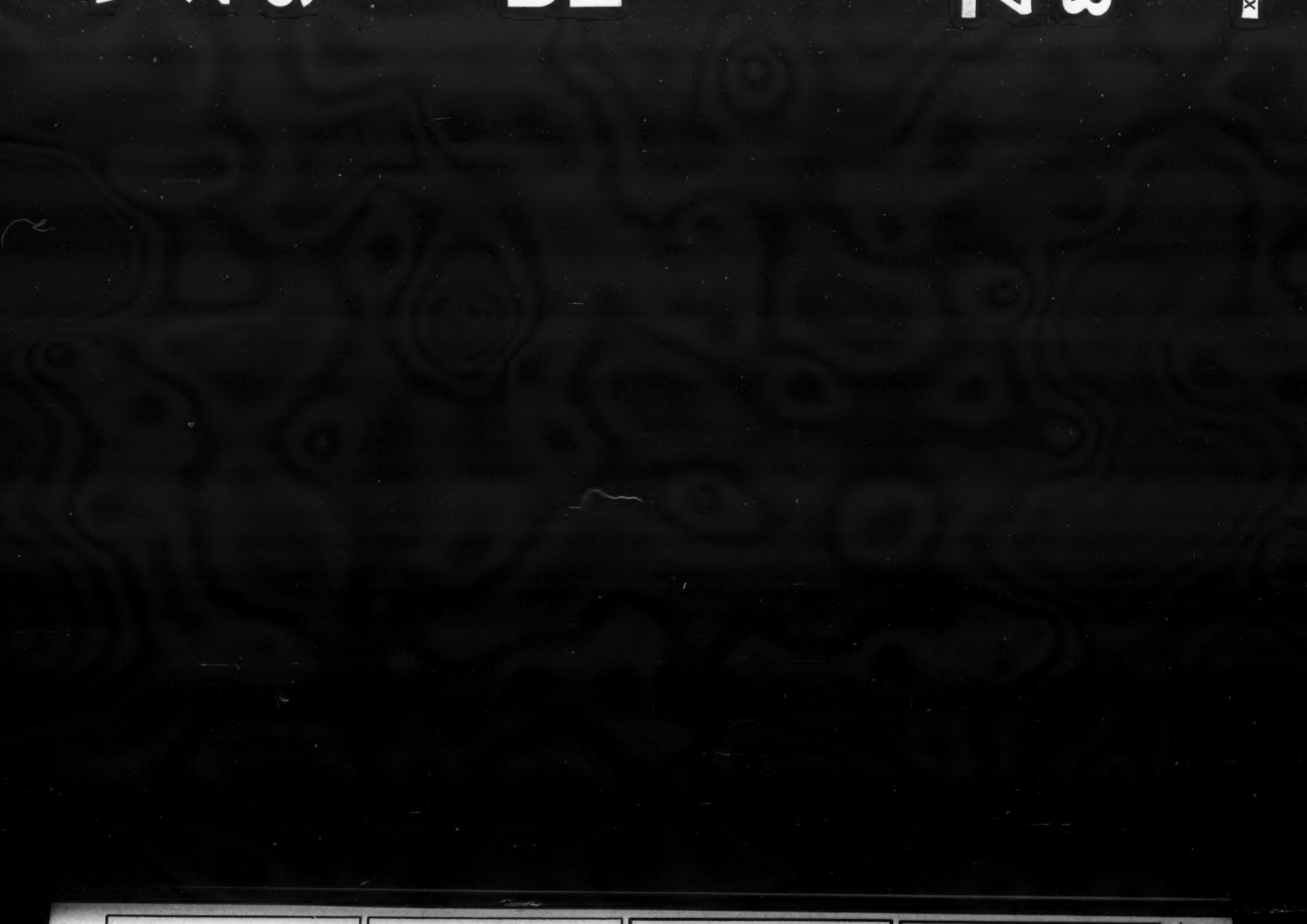
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